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1951

NEW ZEALAND

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

(TWENTY-FIFTH ANNUAL REPORT OF THE)

Presented to the House of Representatives by Leave

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MINISTER'S STATEMENT

THE report of the Department of Scientific and Industrial Research for the financial year ended 31st March, 1951, is presented herewith.

The Department has continued to supply scientific service to the ever-increasing needs of a progressive State as expressed in the demands for assistance arising from various Government Departments and from industry. Through the Department, New Zealand is kept abreast of all scientific developments overseas, and those that are likely to be advantageous here are further investigated, so that their application may be made on sound lines. In view of the extraordinary expansion occurring in scientific effort overseas—and often at great cost—it is important that New Zealand has personnel who both appreciate its significance in relation to our own needs and have the knowledge and facilities which enable them to implement these advances.

Research efforts on a wide series of local problems have continued to add to our fund of local knowledge and, in some spheres, enabled New Zealand to take a lead in its contributions to world science. The primary industries have derived a steady flow of advantages in numerous directions from the achievements of research workers whose efforts have been centred in the fields of crop, insect, and plant disease problems. The interest of manufacturers in the possibilities of research has increased and several industries are likely to benefit from findings made by the staffs of several Research Associations during the year.

The Department has through several of its Branches continued to fulfil at a high standard a number of Commonwealth and international obligations in regard to scientific information gathered and compiled locally.

The Council and Department of Scientific and Industrial Research have continued to promote collaboration of effort with other Departments of State, the University colleges, and other institutions engaged in scientific effort or its application in industry.

T. CLIFTON WEBB,
Minister in Charge of the
Department of Scientific and Industrial Research.

SECRETARY'S REPORT

The Hon. T. Clifton Webb, Minister in Charge of the Department of Scientific and Industrial Research.

I have the honour to submit herewith the annual report of the Department for the year 1950–51.

The year has been one of considerable activity in all Branches of a Department which is required (1) to provide scientific service for all Departments of State and for industries, (2) to maintain certain international scientific services, and (3) to undertake research into a wide series of projects relating to the natural resources of the Dominion.

The provision of scientific services for the State is an essential characteristic of modern government: almost every Government Department requires such service regularly. Science being international in scope, there is in New Zealand a very real need for some scientific organization that will ensure that the results emerging from the vast scientific effort proceeding to-day in all parts of the world are brought to and interpreted into New Zealand usage. The Department's links with overseas organizations and its scientific service enables this to be done effectively.

Scientific service forms a major part of the activities of the Dominion Laboratory, the Dominion Physical Laboratory, the Geological Survey, and the Auckland Industrial Development Laboratory, and reference to the detailed reports of these Branches indicates the extremely wide range of services provided during the year. The Magnetic Survey and Geophysical Observatories, in addition to providing information and service for local requirments, have considerable obligations to meet in the provision of data relating to magnetic, seismic, and other geophysical matters required by Commonwealth and international organizations. Research and service in varying amounts are provided by other Branches, most of which are concerned with problems of the primary industries. The results of research are revealed in a number of findings summarized in the reports of the Branches, and included later in this report.

In many Branches the accommodation position still remains acute and constitutes a serious handicap to effective work. This applies to the Geological Survey, Dominion Laboratory, Botany Division, Grasslands Division, Soil Bureau, and Plant Diseases Division, where conditions remain particularly congested. Some relief has been given to the Dominion Laboratory and the Dominion Physical Laboratory by new buildings and by the efforts of their staffs, who have themselves undertaken constructional work. The position at Head Office has been greatly improved, and after many years of very bad working conditions the staffs of the Information Bureau and the Administration Section are now accommodated satisfactorily.

Staff recruitment during the year has been small, and it has been characterized by more vacancies being filled by graduates from overseas than by graduates from New Zealand University colleges. This may be due to the many opportunities now presented to graduates for overseas study, but the fact is evident that the Department is unable to fill vacancies at the present time by New Zealand graduates. This position prevails in chemistry, biology, and geology, and it indicates the need for some form of collaboration with University colleges whereby students will become aware of the fields of scientific activity in New Zealand of real interest to them.

A Geophysics Division, in which a grouping of all the Department's activities in geophysics has been effected, was established during the year. Further reorganizations to permit of extension of activities have occurred in

the Leather and Shoe and in the Pottery and Ceramics Research Associations. This is indicative of a healthy and vigorous attitude in manufacturing industries towards promoting research.

Public interest evinced in building research has led to a re-examination being made of all previous proposals for a scheme of research, and a new and more limited programme is now in course of preparation.

The presence of the survey ships "Lachlan" and "Discovery II" in New Zealand waters has led to fresh interest developing in oceanography, which has long been neglected. A Oceanography Research Committee has been established and studies of marine conditions in New Zealand waters has been commenced.

One of the major activities of the year has been the search for suitable geological structures in the Wairakei thermal region which will enable the potentially large geothermal steam and hot-water resources of the area to be harnessed for power and industrial purposes. Good progress in the exploratory work has been made to date, but owing to the dissimilarity now evident between Wairakei and the Italian structures at Larderello, much original research will be needed before the New Zealand resources are ready for utilization. In collaboration with the Works and State Hydro-electric Departments, a number of Branches are engaged on thorough and comprehensive investigations of the geothermal resources in the Wairakei area and of the whole of the Rotorua-Taupo region.

In view of the importance of fuel oil to the Dominion, Dr. Lehner, consultant to the Anglo-Iranian Oil Co., was invited to visit New Zealand, and he examined, in association with the Geological Survey and the Geophysics Division, all the likely petroliferous regions, including those which had previously been explored, with a view to assessing their potentialities as sources of petroleum. Dr. Lehner's report is now receiving consideration.

It has been possible during the year to bring up to date the *N.Z. Journal of Science and Technology*, which, owing to persistent printing difficulties, had lapsed into considerable arrears. It is most regrettable that other departmental publications are at present being held up owing to printing difficulties, and vexatious delays in making the results of scientific investigations promptly and widely known and available for application still persist.

The economic value of some of the research findings may be briefly referred to. For years the cause of the dreaded yellow-leaf disease of phormium has remained an obscure and baffling problem. Persistent effort on the part of officers of the Botany, Soil, Plant Diseases, and Entomology Divisions have now defined this as a virus disease transmitted by a somewhat unusual insect *Oliarus atkinsonii*. This finding now clarifies the procedure for attacking the problem by plant breeding and management practices. The Entomology Division's studies of New Zealand grass-grub have revealed how this pest may be controlled at an economical cost by the use of DDT and Gammexane. In view of the very serious losses occasioned annually by grass-grub, it is too difficult to assess the value of this finding, which is certainly far in excess of the cost of the research work patiently undertaken now for some years. The results of research work on varieties, diseases, and fertilizer treatment of the tobacco crop over a series of years is revealed by comparisons made between the average yield per acre in the four years prior to the inauguration of research compared with a similar period to-day. The two figures are 659 lb. and 1,155 lb. of dried leaf respectively, or an increase in value of £74 8s. per acre at the current basic average price of leaf. A considerable proportion of this increase may be attributed to the application by the industry of the results of research.

Research undertaken by the Fats Research Laboratory and the Dominion Physical Laboratory over a number of years has resulted in the establishment of a lucrative fish-liver-oil industry worth some £200,000 annually and making use of material previously neglected. Much of the value of this oil is represented in its high concentration made possible by work done in these two laboratories.

Pasture research at the Grasslands Division has produced strains of grasses and clovers and a system of management that will enable 12,000 lb. to 16,000 lb. of dry matter to be produced per acre annually. When it is recalled that a dry-matter production of 4,000 lb. is required to yield 200 lb. of butterfat per acre (a figure in excess of the present New Zealand average), the potentially high value of this research is apparent. The value of short-rotation rye-grass seed developed by the Grasslands Division has averaged some £150,000 yearly over the past three years. In addition to the value of the seed, the grazing value of this very popular rye-grass has to be taken into account, and it could be quite safely claimed that this would more than double the figure quoted. The costs involved in the breeding and testing of this strain are estimated to have been some £6,000.

Disease-control investigations by the Plant Diseases Division have resulted in marked reduction in dry rot of swedes worth to the grazier some £250,000 per annum; mealy bug, the worst pest in glasshouse grapes, has been brought under control with DDT, resulting in savings of some £18,000 annually; control of eelworm and verticillium wilt of tomatoes in Auckland glasshouse tomatoes has saved some £80,000 annually; some £42,000 annually is a fair estimate of the savings effected in interior renovations of plaster-lined houses owing to its being found possible to control black mould by a method costing approximately 5s. for an average five- to six-roomed house.

This list could be extended considerably; and, furthermore, if one takes into account the day-to-day guidance provided as a matter of course by the Department to all State Departments and to industries, then the value of these scientific services reaches a vast amount.

RESEARCH COUNCIL

The Department is greatly indebted to the members of the Council for the close personal interest they have taken in the work of the Department, for their valued guidance in all matters affecting its welfare and development, and for their advice in the wider field of the bearing of scientific research on the economic development of the Dominion.

The Research Council met on five occasions during the year; in addition, there have been many Committee meetings.

The membership as at 31st March, 1951, was—

T. Rigg, K.B.E., M.A., M.Sc., F.R.I.C., F.R.S.N.Z. (Chairman).
J. C. Andrews, Ph.D., M.Sc. (Deputy Chairman).
E. J. Fawcett, M.A. (Cantab.).
E. R. McKillop, O.B.E., M.I.C.E.
R. O. Page, D.Sc.
H. D. Purves, M.Sc., M.B., Ch.B.
J. M. Ranstead, Bledisloe Medallist, and Dip., C.A.C.
W. Riddet, B.Sc. (Agric.), N.D.A., N.D.D.
D. F. Sandys Wunsch, M.A. (Oxon), B.Sc. (McGill), M.I.Chem.E., Assoc.Inst.M.M.
F. R. Callaghan, M.A. (Secretary).

Towards the end of the year, Dr. N. L. Edson resigned from the Council; his services as a member for several years were greatly appreciated, and his resignation was accepted with regret.

EXPENDITURE, 1950–51

The net expenditure for the year amounted to £903,550. The following was the expenditure incurred in the various branches of the Department:—

	£
Head Office	52,140
Research investigations	316,296
Dominion Laboratory	127,740
Dominion Physical Laboratory	184,318
Geological Survey	78,933
Observatories	39,338
Information Bureau, Scientific Liaison Services, and miscellaneous services	57,355
Auckland Industrial Development Laboratory	27,197
Grants to Universities and agricultural colleges	35,538
Grants, statutory and miscellaneous	16,926
Grants to incorporated Research Associations	25,959
	961,740
Less recoveries	58,190
Net expenditure	£903,550

STAFF

The number of staff of the Department and its disposition at the 31st March, 1951, was as follows:—

Botany, Crop Research, Grasslands, and Plant Diseases Divisions	183	Dominion Physical Laboratory	194
Soil Bureau	76	Auckland Industrial Development Laboratories	33
Geological Survey	79	Observatories	46
Dominion Laboratory and district branches	144	Head Office (including Information Bureau and district offices)	148
Fats Research Laboratory	19	Miscellaneous	88

Total staff, including clerical officers, typists, technicians, and professional officers: 1,010 (964 permanent and 46 temporary). These comprise: professional, 386; clerical, 174; technical, 450.

CONCLUSION

Throughout the year the Department has received much encouragement from the good relationships that exist with other Government Departments, the University of New Zealand and its constituent colleges, the Cawthron Institute, other research organizations, and both the farming and manufacturing industries.

I place on record also the debt which the Department owes to members of the Advisory Committees of the Council of Scientific and Industrial Research for the very real help and assistance they have so readily and generously given during the course of the year.

I wish also to express my sincere appreciation of the loyal and efficient service rendered consistently by all members of the staff of the Department.

F. R. CALLAGHAN, Secretary.

REPORTS FROM BRANCHES

ANIMAL ECOLOGY SECTION

Officer in Charge: Dr. K. Wodzicki

The two major activities of the Section (an intensive study of rabbit bionomics and local surveys of mammal and bird populations) have been continued.

At the Section's field station at Gwavas Forest (Hawke's Bay) some 2,500 rabbits were collected and examined in the field during the year. Useful data on population structure, reproduction, and parasites have been obtained, and is now being prepared for analysis. In the past, rabbit control has had to be planned in the absence of such basic information, and it is probable that before these data can be of general use for such purposes the work will have to be continued for a second year at Gwavas and then possibly repeated in other districts. Information obtained from the analysis of the first year's results should, however, result in a speeding up of future research along such lines. Other work in progress at Gwavas includes the testing of census techniques, the effects of rabbits on pasture composition, rabbit migration and dispersal, feeding rhythms, and other aspects of behaviour. An attempt has also been made to collect information on rabbits in other areas. Results of myxomatosis experiments in Australia are being closely followed.

Local faunal surveys have been carried out in the East Cape, Western Taupo, and Stewart Island areas, and the information obtained has been reported to interested authorities.

The results of a general survey describing the introduction, present distribution, and economic importance of the twenty-eight feral mammals established in New Zealand have been published as Bulletin No. 98 of this Department, and there has been a wide demand for copies by research institutions both in New Zealand and overseas.

APPLIED MATHEMATICS LABORATORY

Director: Mr. I. D. Dick

Projects.—The more important projects completed this year were: the preparation of a bulletin dealing with the analysis of linen-flax yields over a period of three seasons, the purpose of which was to codify information on factors influencing flax yield; investigations into environmental factors affecting fleece production in a commercial flock; a development of factorial designs especially suited for animal experiments; and the special problems dealing with the frequency distributions of certain biological material, particularly aphids.

The work in the analysis of time series has been greatly advanced by the publication of a doctoral thesis, "Hypothesis Testing in the Analysis of Time Series," by an officer of the Laboratory studying overseas. Another doctoral thesis on "The Design and Analysis of Systematically Designed Experiments" has been submitted for publication.

Of the projects under investigation, the more important were: design of sampling survey methods for estimating agricultural and pastoral production statistics more quickly and cheaply than is possible by the method of complete enumeration; encouraging progress in methods of assessing rabbit populations (in collaboration with the Animal Ecology Section); theoretical investigations into the modifications required for the correct analysis of experimental results when the treatment effects are neither strictly additive nor multiplicative, but a

combination of both (this problem was brought to the attention of the Laboratory by the Ruakura Animal Research Station, where such effects were strongly suspected in certain of the identical-twin experiments); investigations into the accuracy of food-testing panels; and a preliminary investigation on the suitability of natural populations of Californian poppy (*Eschscholtzia californica*) in Canterbury and Otago as material for genetical population studies has been started (this plant may prove valuable in showing how genetic characteristics are spread in migration).

Computations.—A large number of computations has been performed. Some of the more important were: analysis of records on 30,000 sheep for the Wool Metrology Section, Canterbury Agricultural College; computation of correlograms and spectra for observatories; analysis of personnel selection records for the Army Department; and estimation of valve performance for the Broadcasting Service.

AUCKLAND INDUSTRIAL DEVELOPMENT LABORATORIES

Director: Mr. J. B. Brooke

Industrial servicing has in the past taken up most of the time of the Laboratories, but during the year efforts have been made to increase research and development work. Much of the servicing work hitherto carried out could have been done by the industries themselves, and the Laboratories are now assisting industrial groups to do this. If, however, no facilities exist in New Zealand outside the Department for the work, and where the process is uneconomic to industry or where accurate reference has to be made to standards and there is a need for independent authority for certification, then the Laboratories will continue to render this service. The equipment and collaborative skill of the Department's staff will be always available, since close contact with the New Zealand industries is an important objective, but the main objective—not to be supplanted by routine services—is development.

PHYSICS SECTION

A major portion of the time has again been spent in servicing optical instruments and in general calibration work. A further set of six short-path flow cells for blood-oxygenation determination has been completed for the Auckland Hospital. Much time has been spent in certifying the dry weight of wool samples. Assistance has been given in developing deep-bore thermometers for the Wairakei geothermal investigations. Relative abrasion tests have been carried out on various materials—false teeth, linoleum, and carpet. Lens blooming has been handled through this Section at the Naval Dockyard.

ELECTRICAL SECTION

Medical Instrumentation.—Considerable work has been done on the development and application of a high-speed pressure recorder for the direct recording of arterial and venous pressures in man. Accurate records are made of the pressure cycles in the heart and adjacent arteries, the pressure being conducted to the equipment by an intra-cardiac catheter. Arterial and venous pressures may be recorded directly through extremely fine needles. Experiments are revealing many new applications for this equipment.

Preliminary work has been done on the development of equipment for continuously recording the oxygen saturation of arterial blood in cases of congenital heart-disease.

Electronic Control of Blanking Press.—A modified and improved equipment has been built for the accurate positioning of stock in a strip blanking press.

Millisecond Chronograph.—A chronograph has been developed for the accurate determination of time intervals up to several minutes to an accuracy of 0·0001 second.

General.—Modifications and improvements have been made to a large-scale automatic wallboard-processing plant. A wide range of industrial control equipment has been serviced and calibrated.

DESIGN SECTION

A third molecular still embodying new control devices has been completed, installed, and tested under manufacturing conditions.

Equipment for the measurement of the quantity and quality of steam produced from steam bores at Wairakei has been designed and has been in operation whenever moderately dry steam has been obtained.

A large press for a plywood manufacturer has been fitted with a load-indicating device from which the pressure at the glue-line can be obtained.

Tests have been carried out on the efficiency of locally-produced orchard-spraying units.

A vane-type instrument for measuring the shear strength of soils has been constructed for the Soil Bureau, and a rotary seed-dusting machine for the Plant Diseases Division.

A lens-milling machine of similar type to the equipment developed for the Laboratories' own use some years ago has been constructed for the Dominion Physical Laboratory.

The success of the newspaper-wrapping machine developed by this Section has led to a demand for five additional machines, which are being constructed locally.

METALLURGICAL SECTION

This Section has developed considerably and, with the installation of the 30-ton Tinius Olsen universal testing-machine, is now fairly well provided with mechanical testing equipment.

The projects undertaken by this Section are: mechanical testing of welds, welding-rods, plate, &c., for fabrication of equipment for the State hydro-electric undertakings; examination of failed components in the automobile and aviation field—axles, gears and gear-boxes, cylinder blocks, pistons, aircraft valves, &c; analysis of steels, bronzes, and alloys of aluminium; control and checking of heat-treatment procedures and the heat-treatment of tools and die blocks; control and checking of plating-baths; control of alloys used for die-casting and design of dies.

WORKSHOP SECTION

With the installation of the new Cincinnati tool-room milling-machine, milling capacity has been considerably improved.

Further embossing rolls of intricate design have been produced and a considerable amount of engraving work has been carried out on dies and moulds for industry.

Repairs to precision instruments still occupy a considerable part of the time of the fine instrument section, although efforts are being made to arrange for industry to do this work itself.

BOTANY DIVISION

Director: Mr. C. M. Smith

STAFF

On Mr. A. L. Poole's joining the New Zealand Forest Service on 1st January, 1951, Mr. C. M. Smith was appointed Director.

HERBARIUM

The past year has again shown the importance of this section. Through the increasing demands for the services of the herbarium, coupled with the scanty accommodation, development is becoming even more difficult.

TAXONOMIC BOTANY

Although lack of staff has not permitted the formal projects in taxonomic work to be increased in number, the work on the genus *Agropyron,* a genus of grasses with indigenous representatives, has proceeded unchecked without diversion of the workers into other fields. The taxonomic work on the genus has now spread into the related field of plant-breeding and small-scale comparative trials of results for such qualities as growth habit, self-fertility, seed yield, &c.

The senior officer specializing on seaweed work pursued taxonomic studies of indigenous algæ, and presented a paper on taxonomic subjects at the International Botanic Congress in Sweden. This paper was of fundamental importance in clarifying a much disputed problem of a very long standing amongst algological taxonomists, and secured universal acclamation and credit for the officer concerned.

ECOLOGY

Tussock Lands.—Detailed analyses of the principal vegetation units have continued. The primitive tussock community has been so modified that it is gone for ever as a vegetational community, and its full primeval constitution may now never be reconstructed. The major species themselves are already incurring danger of ultimate extinction as species. Studies of the species that still are the dominant features of the community have been intensified, and an officer has been stationed in Christchurch to assume this task in South Canterbury. Four separate aspects of the tussock grasslands are now receiving special and detailed attention, though results to date serve chiefly to emphasize the lack of knowledge both among scientists and practical users of tussock land of the details of the fundamental plant processes involved. The advent of Nassella tussock and its firm occupation of much lowland tussock grassland serves to exemplify the possible results if natural tussock land is allowed to deteriorate until a substitute species finds opportunity to establish a rival community.

Water-weeds.—The year under review saw an increase in the calls made on the Division for information concerning these hitherto scantily known plants. Information and advice were sought by engineers concerned with drainage system clearance, by shooting interests concerned with maintenance and increase of wild-duck population, by fishing interests concerned with apparent growth of green plants at hitherto unrecorded depths in Lake Taupo, and by agricultural officers faced with applications to import alien water-plants in attempts to acclimatize them, &c.

No one can prophesy with even reasonable certainty how an alien plant will behave if released under changed environmental conditions, and water-plants are even less informative and less controllable for observation under quarantine than are terrestrial plants, there being always the danger that the water currents will disperse small particles capable of growth even through the best of barriers.

The occasional application to introduce water-plants for ornamental and horticultural purposes also raises a problem. Even the plant that is genuinely innocuous from the horticultural viewpoint can behave very dangerously if it has access to a suitable niche beyond garden or aquarium limits.

The aquatic florula that is making its appearance in the impounded sea-water ponds of the salt-works at Grassmere was of interest. With the varying saline content of the pond series there were naturally vegetational phenomena that had not been foreseen. So far they have fortunately been interesting to the botanist without being, so far as can be seen, at all ominous for the industrialist. It is of interest, and certainly it was unexpected, to find that one marginal deposit, when examined microscopically, showed a conspicuous content of pine-pollen grains, apparently sea borne.

Palynology.—The group of officers dealing with pollen examinations has continued to be fully occupied, and knowledge is being systematically accumulated and disseminated about this little-studied aspect of botany. The number of stations that regularly submit collections of atmosphere-borne pollen for examination was not increased during the year, as the present routine of punctual daily analysis of collections submitted was as much as the staff could cope with. It is planned, however, to add two South Island stations to the collecting list next season.

Honey analyses and examination of peat deposits for pollen-bearing strata are other aspects of this work that have been continued, and the latter has been extended by the attachment of a palæobotanist from the Geological Survey to the palynological group.

The peaty and jelly-like deposits associated with the moa remains in Pyramid Valley in North Canterbury are being studied as part of a joint project led by zoologists and ethnologists and designed to describe in detail the site of deposition.

Forest Distribution.—The officer who studies the forest ecology and the forest distribution of the Central Volcanic Plateau has carried out some of his primary vegetational surveys in association with officers of the Soil Bureau. The observations of the two different types of officer have been found to be often interlocking and sometimes mutually corrective.

ECONOMIC BOTANY

Nearly all the activities already described have an economic bearing, either direct or indirect.

Seaweeds.—The officer who has for many years past been investigator and adviser on collection of raw material for agar manufacture from New Zealand seaweeds visited commercial seaweed-collecting fields in Great Britain and Eire and some of the factories processing materials for seaweed products. The report covers British manufacture of alginates and of agar, and points out that present world demand for the alginates used in food and baking industries, in textile and paper industries, in rubber, plastic, and paint industries, and in pharmacy, dentistry, and surgery, does not appear sufficient to encourage any effort to attempt production in New Zealand. Agar used in some industries and most significantly in bacteriology, in preserved foods, and to a limited extent in soft-drink industries and in confectionery, has a very good reputation as a New Zealand product on a limited market, but faces severe competition from the Japanese product, which differs, however, in some properties. There is also a certain degree of competition from British-manufactured agar, which differs again from both of the others. With maintenance of quality and of uniformity of product, the New Zealand agar should hold a place on the restricted markets available.

The report and its cautious conclusions, however, emphasize the fact that continued research aimed at assembly of information is justified. Though the seemingly restricted demands do not promise large returns for new commercial enterprises, there can possibly be sudden national emergency demands where quick manufacture would be vital.

Phormium tenax.—Work during the past year has been sharply focused on a search for the elusive cause of the yellow-leaf disease. The concurrent efforts of mycologists, entomologists, physiologists, and ecologists are at last converging on a diagnosis which appears to account for all of the perplexing symptoms that have defied explanation for over a quarter of a century. Diagnosis is not remedy, but it will make the search for appropriate remedial methods more purposeful and more concentrated. A widely distributed native hopper insect appears to be the vector of the still unisolated causal organism, and this insect is in its larval stages completely killed out on land that is deeply inundated for several days in the year. It survives on small areas not so flooded and slowly spreads again from such survival niches. Spread is hastened by planting out of fans from infested areas.

These results, though as yet tentative, are sufficiently indicative of probable future trends to enable the programme of the past to be curtailed in certain directions. The vegetational survey referred to in last year's report has therefore now been discontinued, and the attempt at breeding for disease resistance likewise, although these may be resumed when the whole story of the disease has been brought to light.

MISCELLANEOUS

Illustrations.—A full series of line drawings of New Zealand mosses has been completed by the artist in addition to the usual work for all the sections.

Publications.—Two bulletins and eleven articles were written by the staff and published.

CROP RESEARCH DIVISION

Director: Dr. O. H. Frankel

The amalgamation of the Agronomy Division and the wheat-breeding section of the Wheat Research Institute took effect from 1st April, 1950. In future, research on all field and vegetable crops will be looked after by this organization, which has been named the Crop Research Division.

RESEARCH ON FIELD CROPS

Hilgendorf Wheat.—A questionnaire on this variety was again circulated to growers, but only a small proportion of the total replied. Although the season was favourable, heavy rain in January and February delayed the harvest, so that many crops were left standing long after they were ripe. Hilgendorf did not stand up to these conditions as well as Cross 7, and several growers, though otherwise satisfied with the variety, commented on the weakness of the straw. About 50 per cent. of the growers were satisfied, 16 per cent. were uncertain or had decided against it without stating their reasons; and 34 per cent. were not satisfied. In yield, Hilgendorf is not as reliable as Cross 7, but its high baking quality warrants continuance of the premium, without which it is not likely to be extensively grown.

Four lines selected from the material that yielded Hilgendorf were tested in nine localities. One with apparently better yield and baking quality than

Cross 7 may replace Cross 7 in certain areas, and two other lines which were closer to Hilgendorf in yield and quality are now being considered as replacements for Hilgendorf.

Of crosses between Hilgendorf and Cross 7, only one yielded significantly better than Cross 7, but many were similar in quality to, and considerably better in yield than, Hilgendorf. A replacement for Hilgendorf may be found in this material. Lines from this cross are being used to continue the study of the relationship of protein content to baking quality.

Yielder Wheat.—This new variety has now been released as a replacement for Fife Tuscan. Although inferior to Cross 7 in milling quality, it is a higher yielder, and it is superior to Fife Tuscan in baking quality.

New Varieties of Wheat.—Further tests of the eleven advanced lines reported on last year gave similar encouraging results. The four most promising lines will undergo more searching tests, and in the meantime nucleus seed for distribution is being built up.

In addition, two other lines that have shown promise will be tested in extensive trials for the first time.

Disease Resistance of Wheat.—It is widely believed that the incidence of mildew has been increasing in seriousness in recent years. Regent, a Canadian variety, is resistant to all five races of mildew, but is not agronomically suited to New Zealand conditions. An attempt is being made to transfer the resistance of Regent to four of the most important New Zealand varieties. The isolation of the races of mildew and the testing of hybrid material is being carried out with the co-operation of the Microbiology Department of Canterbury Agricultural College.

Wheat Investigations.—Studies on the inheritance of quantitative characters, on mildew resistance, and on the effects of various methods of selection are being continued.

Oats.—Breeding for resistance to lodging has been continued, using the Welsh varieties, S172 and S225, as parents. Last season, in Extension Division trials, S225 yielded as well as Onward and was very resistant to lodging. The grain is moderately large, and this variety will be included in further trials. S225 has been crossed with Abundance and Onward.

Stem rust and crown rust are sufficiently serious in some seasons to reduce the yield and quality of both grain and chaff. A number of varieties which have proved resistant to New Zealand races of these rusts during the last two seasons have been crossed with Abundance and Onward. Testing and selection is proceeding in the glasshouse and in artificially infected rust nurseries.

Varieties more suitable for general purposes or stock-feed are being tested, and five appear sufficiently promising to warrant inclusion in extensive trials during the coming season.

Barley.—In the Marlborough district Pryor is satisfactory to the grower, but its malting qualities are less so to the brewer. In the Canterbury district Research is reasonably satisfactory to the grower, although he would prefer a variety with greater resistance to lodging and "neckbreak," but it is unsatisfactory to the maltster mainly because of its uneven ripening.

Kenia seems likely to replace Pryor in Marlborough because it has considerably better malting quality and is highly satisfactory from the grower's point of view.

One promising selection from the Australian variety, Research, will be released to growers for the 1951–52 season.

A close review of the varietal needs of the barley industry suggests that deliberate breeding for New Zealand conditions may effect further improvements, but present facilities for the testing of quality are inadequate. It should be borne in mind, however, that in the wheat industry 90 per cent. of the total acreage is sown with New Zealand bred varieties.

A field trial of five Danish varieties of the Kenia type at Ellesmere indicated that the variety Herta was outstanding in yield and in resistance to lodging. The malting quality of these lines is now under test by a commercial malting firm. In Marlborough trials, Herta was resistant to lodging; yields are not yet to hand. Trials of hybrid material at Ellesmere were invalidated by heavy rains in January, but reserves of seed are being held for future sowing.

Rye-corn.—The N.I.A.B. rye-corn, first introduced from Great Britain seven years ago, has been shown to thrive under cold, or dry, conditions, and to stand up to repeated hard grazing. It is now in widespread demand as a cereal greenfeed for winter and early spring.

Rye-corn being a cross-fertilized plant, it should be possible to adapt this variety further to New Zealand conditions. Selection, based on the "polycross" method, has been initiated.

Potatoes.—Virus-free seed of nine varieties was imported from the British Ministry of Agriculture, but one variety and single plants of three other varieties were found to be infected. The rest are being increased for distribution. No clean stocks of Aucklander Short-top and Dakota have been found, but crops of virus-free Arran Chief have been located in Southland.

Five Australian hybrids immune to virus X and field-resistant to viruses Y and leaf-roll have been introduced and crossed with good commercial varieties.

Scottish and American varieties resistant to late-blight maintained resistance at Pukekohe but succumbed at Lincoln, suggesting the presence of a different strain of the fungus. As the new strain probably occurs in the North Island, the resistant varieties from overseas are likely to break down in resistance if cultivated on a large scale. Local breeding is clearly necessary, and hybrids immune to all known strains have been crossed with good commercial varieties.

Twenty varieties of potatoes grown at four centres have been analysed for vitamin C content at harvest and after storage for varying periods (see report of Plant Biochemistry Section).

The methyl ester of alpha-naphthalene acetic acid and tetrachlornitrobenzene applied to tubers gave effective control of sprouting until October, either in a clamp or in an open shed. When used on seed potatoes, the methyl ester delayed emergence from the soil, but the effect was considerably reduced if the tubers were exposed to the air for three to four weeks before planting. Tetrachlornitrobenzene slightly delayed emergence, but the effect was entirely overcome by exposure for three weeks.

Rape.—Two of thirty-seven lines bred from club-root-resistant rape showed a trace of the disease, while all Broad Leaf Essex plants were severely attacked.

A resistant Broad Leaf Essex will avert crop failures in those large areas where the disease occurs sporadically. A number of lines homozygous for resistance have been isolated from the cross between Broad Leaf Essex and club-root-resistant rape, but their yielding ability is yet to be tested.

Progenies of two plants selected for aphis resistance were less severely attacked by aphides than neighbouring plots of Broad Leaf Essex, but their leaf production is at present inferior.

Kale.—Trials of hybrids gave substantially the same favourable results as in previous years, and seed-supplies are being increased for early distribution.

Lines of kale and chou moellier have been obtained from overseas, and a selection and breeding programme has been planned which will almost certainly give higher yielding varieties.

Swedes.—A variety with high club-root resistance, selected by the Department of Agriculture, is being used to introduce resistance into our established varieties.

No variety immune to dry-rot is known, but a search for resistance is being continued.

Linen Flax.—As the Plant Diseases Division has detected a new race of rust that attacks varieties immune or resistant to the previously known races. the breeding project to transfer the resistance of the Russian varieties and Ottawa 770B to Liral Crown by backcrossing has been modified to introduce also the resistance of Bombay, which, although susceptible to some other races, is immune to the new race.

Linseed.—Since linseed is also susceptible to rust, a modification of the breeding programme is being made similar to that for linen flax. A search is being made for a variety that will flower earlier than Bison in the cool showery climate of Southland, since difficulty is often experienced in harvesting owing to adverse weather in the autumn.

Sweet Blue Lupins.—A variety obtained from Sweden has given green-matter yields similar to those of the bitter blue lupin and is being multiplied for field trials.

Sweet Yellow Lupins.—The non-shattering variety has given yields of green matter similar to those of the shattering New Zealand sweet yellow. Both varieties carry the Strain 8 factor for deficiency of alkaloid.

Bitter Blue Lupins.—The varieties with rapid early development gave higher green-weight yields than the New Zealand bitter blue but produced less leaf.

Peas.—Field trials have been conducted of the following bred material: (i) early garden peas, higher yielding than William Massey; (ii) mid-season garden peas of Greenfeast type, resistant to pea-mosaic; (iii) blue field peas of higher yield than Blue Prussian.

Selections in a cross between Partridge and Black-eyed Susan have been increased for further trial, while single plants selected in both Partridge and Blue Prussian are being increased for future certification. Breeding for resistance to *Fusarium* wilt in garden and field peas is continuing. Introductions of blue field peas and canning peas have been under trial at Lincoln, while canning tests on promising material bred at the Division have been carried out by the School of Home Science, Dunedin.

Lucerne.—Work on the improvement of grazing and hay lucernes is continuing.

RESEARCH ON VEGETABLE CROPS

Plant Introduction and Variety Trials.—Following on the general survey of 1,800 strains and varieties of all the main vegetables, more comprehensive trials have been carried out on 41 varieties of broccoli and on 30 varieties of tomatoes to further the selection of varieties for the breeding and selection programmes.

Two strains of broccoli bred in Devon, England, have given good results in the coastal areas of the South Island.

A small trial showed that hybrid seed of Marcross sweet corn could be produced with characteristics at least equal to those of imported lines of Marcross. This fact may be significant if the introduction of disease in imported seed is to be avoided.

Purification of Stocks.—Two methods are being used in the production of improved strains: (*a*) the bulk seeding of selected plants followed by progeny-testing and further selection, the process being repeated several times; and (*b*) the development of inbred lines followed by crossing of the inbreds.

(*a*) Lines of Savoy cabbage that have been developed show great improvement over commercial lines available in New Zealand in respect of percentage of marketable heads and uniformity in type and maturity. Six improved strains of Savoy cabbage and four of broccoli are in various stages of development.

(*b*) Approximately 60 single plant selections of Savoy cabbage have been self-pollinated, the method of bud pollination being necessary to ensure seed setting in this normally self-sterile plant. Similar improvement work is being carried out with carrots.

Breeding.—Work has continued on the production of a male-sterile Pukekohe onion for use in the production of hybrid onion-seed.

PLANT BIOCHEMISTRY

Vitamin C in stored potatoes was lost much more slowly from Aucklander Tall-top, Inverness Favourite, and Up-to-Date than from other varieties.

A series of selections from chou-moellier crosses has provided material for the study of differences in important nutritional and biochemical factors such as lignin, cellulose, protein, and soluble carbohydrates. These data give information on digestibility, body-building, and fattening properties of the plants. Considerable differences are apparent in the amounts of these constituents present in the varieties tested.

Long-term investigations on the biochemical factors involved in disease resistance and the physiological genetics of alkaloid production in sweet and bitter lupins have been initiated.

SUBSTATIONS

A substation has been established at Papatoetoe near Auckland, primarily for vegetable research, in which the aim is to produce varieties specifically suitable for the Auckland Province and to breed for disease resistance in co-operation with the Plant Diseases Division.

Work on Brassica crops is still hampered through staffing difficulties at the Gore substation, but an officer has now been appointed and will take up his duties in the spring of this year.

The substation for vegetable research at Havelock North will also be established shortly, soon after the return of an officer from overseas.

Strong representations have been made by farmers in the South Canterbury district asking for research on the improvement of Dreadnought wheat. A co-operative research scheme that will greatly rely on the direct help of farmers in the district is now under discussion.

DOMINION LABORATORY

Director: Mr. F. J. T. Grigg

The Laboratory has continued to discharge its functions as a chemical service and research laboratory under increasingly difficult conditions, especially as regards accommodation. Some relief has been given by the fitting-up of a laboratory for the Chemical Engineering Section in part of a temporary building erected as a bulk store at Gracefield Road, Lower Hutt, but it is evident that the old buildings at present occupied in Wellington are quite inadequate if the Laboratory is to continue to meet effectively the many demands on its services.

The following table shows the number of samples received during 1950 by the Dominion Laboratory, Wellington, and the district laboratories in Auckland, Christchurch, and Dunedin.

Contributor or Department.	Wellington.	Auckland.	Christchurch.	Dunedin.
Agriculture	18	1	548	83
Air	76	2	..	..
Army	21	2	..	..
Broadcasting	19	..	..	..
Customs	147	47	4	32
Education	5	..	..	..
Forest Service	12	79	..	1
Health	5,419	7,274	4,814	2,391
Hydro-electric	152	..	1	..
Industries and Commerce	51	..	2	..
Internal Affairs	7	..	..	1
Island Territories	5	3	..	..
Labour	1	1	..	87
Lands and Survey	..	..	4	6
Local Bodies	50	24	708	51
Main Highways Board	105	..	..	..
Maori Affairs	6	..	..	..
Marine	317	..	..	..
Marketing	111	285	..	60
Mines	1,746	1	..	..
Navy	14	13	..	..
Plunket Society	168	105	125	40
Police	122	225	210	73
Post and Telegraph	67	12	9	1
Pottery and Ceramics Research Association	9	..	..	..
Printer	4	..	..	..
Prisons	83	..	..	..
Public Trust	1	..	..	1
Railways	12	10	33	14
Scientific and Industrial Research—				
Information Bureau	106	..	..	..
A.I.D.L.	1	4	..	..
Botany Division	5	..	..	..
Dominion Laboratory	99	..	2	43
Oceanographic Observatory	..	..	1	..
Fats Research	3	..	..	..
Fruit Research	..	..	..	73
Geological Survey	141	3	17	3
Physical Laboratory	19	..	..	..
Plant Diseases Division	147	1,545	..	..
Soil Bureau	24	..	..	..
Industrial	19	1	64	98
Standards Institute	10	..	..	..
State Advances	135	62	..	2
Stores Board	30	..	..	..
Works	631	41	67	12
Miscellaneous	882	2	65	14
Total	11,000	9,742	6,674	3,086

ROCKS, MINERALS, AND CLAYS

Chemical and advisory work in this field is an important part of the work of the Laboratory, since these naturally occurring raw materials form the basis of some important New Zealand industries. Close collaboration was maintained with the Geological Survey in all matters relating to mineral resources; also for this Branch of the Department special analyses of rocks are made with particular attention to the determination of the minor and rarer constituents.

A start has been made on the study of techniques for the use of isotopes, both stable and radioactive, in research, but the specialized laboratories essential for this work do not yet exist. With the restricted facilities available, some work has, however, been done: for the Soil Fertility Research Station of the Department of Agriculture several pounds of superphosphate containing radioactive phosphorus was prepared for use in fertilizer experiments, and assistance was given in the medical use of a radioactive isotope of phosphorus.

Work was done on a variety of problems connected with cement and concrete. The work on pozzolanas was continued and a report prepared on the results so far obtained. The Ministry of Works asked for an investigation on the possible danger of corrosion of steel reinforcing-bars when these are used in concrete in conjunction with copper conduit, and regular tests were made on cement that was being used in the construction of dams. The survey of raw materials for the manufacture of cement, carried out in conjunction with the Geological Survey, was completed. Aggregates used for concrete, especially in dams in the Waikato basin, were tested for "reactivity" with high-alkali cements. Two methods were used—the rapid chemical method (Mielencz) and the mortar-bar test (Stanton). Some data obtained by the latter method have been incorporated in a preliminary report.

Because of the critical position of sulphur supplies, it is urgently necessary to investigate alternatives to the use of sulphuric acid for making the phosphorus of rock phosphate available for fertilizers. A preliminary study has been made of the fusion of rock phosphate with dunite and with mixtures of greensand and dolomite; further experiments are planned.

In co-operation with the Geological Survey, the deterioration of the concrete linings of four railway tunnels on the Stratford-Okahukura line was investigated, and remedial measures were suggested. Investigations were also made in Wellington and Dunedin on the effect of smoke on the concrete lining of railway tunnels. The work indicated that the effect of sulphates in ground water penetrating the linings was at least as deleterious as that of sulphur dioxide in the smoke.

The very severe disintegration of clay tiles on the roof of the Wellington Public Hospital was shown to be due not to frost action, as supposed, but to crystallization of soluble sulphates in the pores of the tiles. Both imported Marseilles tiles and locally made tiles had failed after only twenty years' exposure. Salts from sea spray had probably also been a factor, as in a previous case at Wanganui College.

FOOD, DRUGS, AND WATER

An important part of the work of the Wellington Laboratory and branches consists of the examination of food, drugs, and water on behalf of the Department of Health, which administers the regulations under the Food and Drugs Act.

The quality of milk-supplies in the Health Districts of Wellington, Palmerston North, New Plymouth, Gisborne, and Nelson showed a marked

improvement compared with the preceding year. Of 3,882 samples (600 fewer than last year), only 2 contained added water, 17 were below the standard for fat, 27 were insufficiently pasteurized, and 7 were stale. The Wellington City supply was again of a very high standard.

In the Auckland Province, milk-supplies cannot be regarded as entirely satisfactory. The city supplies are, however, better than those of the outlying districts. Of 2,558 samples in Auckland City, 13 contained added water, 16 were deficient in fat, and 38 failed in the reductase test. In the provincial districts, out of 2,182 samples taken, 38 contained added water, 58 were deficient in solids other than fat, 23 in fat content, and 55 failed in the reductase test. The visible dirtiness of milk-bottles throughout the Auckland Province was a source of concern at intervals during the year.

The milk-supply in Christchurch has reached the lowest standard of quality in fat, solids other than fat, and total solids recorded since the Laboratory commenced analyses in 1926. The deterioration in solids-other-than-fat content, which has become more noticeable each year, progressed to the point where for the months of July, August, and September almost all samples were below 8·5 per cent., and it was common for treating-house samples to average about 8·2 to 8·3 per cent. This most unsatisfactory position arises mainly from the use of low-testing cows. Milk protein is at least as important as fat as a constituent of milk, and measures should be taken urgently to improve the quality of the Christchurch supply.

Of 2,012 samples in the Christchurch metropolitan area, 33 were below the standard for fat, 308 were deficient in solids other than fat, and 9 failed in the reductase test.

Of 861 samples in Canterbury provincial districts, 30 were deficient in fat, 136 were deficient in solids, 3 contained added water, and 11 failed in the reductase test. On the West Coast, of 132 samples, 5 were deficient in solids and 1 failed in the reductase test.

In the Otago and Southland districts the number of milk samples taken again fell considerably, largely because much of the milk is now bulked at the Dunedin treatment station, the suppliers to which are sampled by the treatment station itself. In Dunedin the composition of the milk supplied has not altered materially, and the proportion of stale raw milk remained too high at slightly less than the previous year. In the other districts there was some general improvement in milk quality.

The sampling and analysis of foods extended throughout the country and covered all kinds of food and drink. Typical examples are given below.

Of 653 samples of cream examined by the Wellington and Christchurch laboratories, about 50 showed a marked deficiency in fat, while 47 were classified as stale. Of 60 milk-shakes examined in Christchurch, 12 were deficient in fat and 27 contained living coliform bacilli. About three-quarters of the milk-shakes were made from raw milk, and the remainder from pasteurized milk. In Dunedin, 14 of the 48 samples of milk-shakes analysed contained less than 3 per cent. of milk fat, and 8 examined for coliform organisms all failed to comply with the standard. Of 134 samples of ice-cream examined in Wellington and Dunedin, only 4 contained less than the permitted minimum of milk fat. Over half the Dunedin samples failed to comply with the standard for coliform organisms.

Boric acid was found in very few samples of bacon examined in Wellington, but in Auckland it was found in 16 samples of bacon, 3 of black puddings, 2 of luncheon sausage, 1 of brawn, and 1 of tripe. As a residue from the bleaching of tripe it was found in 5 out of 12 samples of

tripe in Wellington and 9 out of 12 in Dunedin, but was not found in Christchurch. In all four districts it was found that sulphite was being dusted on fresh meat as a preservative, and excessive amounts, up to nearly 5,000 parts per million, were being added to sausages and minced meat. Salicyclic acid and excess of sodium benzoate preservatives were found in beverage syrups.

Various foods, but mainly bread, about which complaints of the presence of foreign matter were made, were found to contain materials such as pieces of metal, cigarette ends, insects (living and dead), rodent droppings, and lubricant grease from breadmaking machinery.

Many chemical and bacteriological tests, including resazurin reductase tests, were made on Australian and New Zealand frozen egg-pulp as supplied to bakers and pastrycooks. The quality varied from excellent to quite unusable. Both imported and New Zealand made metal tea urns and jugs were examined for the presence of lead in the solder used in the interior. Of 5 samples submitted, only 1 was satisfactory.

Nearly 1,000 samples of water taken mainly from public supplies were subjected to chemical analysis and a somewhat greater number were examined bacteriologically. These examinations enabled potentially dangerous supplies to be distinguished and protective measures taken by the Department of Health. The survey of water-supplies for fluorine content was continued, the analyses to date indicating that from the point of view of their effect on the teeth of children the supplies are probably quite satisfactory. The final verdict must await the completion of research work being carried out by officers of the Department of Health.

Three hundred and seventy-one samples of sea-water collected by the survey ship H.M.S. "Lachlan" were analysed for phosphate and salinity.

Several hundred samples of drugs were analysed, mainly in the Wellington laboratory. Most were drugs for which standards are set by the British Pharmacopœia, the Pharmaceutical Codex, and the New Zealand Formulary. On the whole, the drugs examined were of reasonable quality, although some failed to comply with the standards.

Bacteriological work on milk, milk-shakes, cream, ice-cream, egg-pulp, and other foods, and on water, was carried out in all four laboratories. This work is becoming a very useful adjunct to the chemical work on foods.

MEAT RESEARCH

Research work on meat, which had been commenced in 1949 with a brief investigation of a method for the dehydration of minced meat worked out at Cambridge, was directed towards the production of dehydrated meat in larger-sized pieces, which should have a more acceptable texture than mince. A product has been successfully made which had a well-distributed moisture content of about 10 per cent. and was acceptable in appearance and palatable when cooked. It is hoped to build a pilot plant capable of handling about 50 lb. of raw material and thus provide sufficient dried material for extensive storage trials.

It was found practicable to store bacteria in a freeze-dried condition, and a "bank" of organisms associated with meat spoilage is being established.

A study of the conditions of transport of New Zealand export meat was commenced with an investigation of the time taken at each stage in the transport of meat from the works to the ship's hold. In an attempt to improve on the measurement of bone temperature of carcasses at the wharf as an indication of adequacy of refrigeration during transport to the ship, a simple penetrometer was devised to measure the hardness of the surface of the carcasses.

ORGANIC CHEMISTRY

The study of resinous constituents of exotic pines in co-operation with the New Zealand Forest Service was continued. Projects on the distribution and composition of resins in the woods of *Pinus laricio* and *P. murrayana* were concluded. Investigation of the resin, wax, and sterol constituents of *P. laricio* bark was carried out. Four phenolic diterpenoids similar to those obtained from woods of several *Podocarpus* species were shown to be present in the resin of wood from rimu (*Dacrydium cupressinum*). Oxygenated diterpenoids of the type characteristic of *Dacrydium* species were absent.

Many problems involving the organic chemistry of plastics, rubber, textiles, wood, and adhesives were investigated.

TOXICOLOGY AND FORENSIC CHEMISTRY

Many examinations of post-mortem and other specimens for poisons were made in all four laboratories. As usual, barbiturates, arsenic compounds, and strychnine were most frequently met. Less commonly found were cyanides, nicotine, hydrochloric acid, codeine, chloral hydrate, Lysol, chloroxylenol, Camphosa, petrol, and alcohol.

A faulty dry-cleaning plant was responsible for the death of an operator from inhalation of trichlorethylene. This is apparently the first death from this cause in New Zealand.

A boy aged three and a half years died after taking ten to fourteen 50 mg. anthisan pills. This is the first recorded death in New Zealand caused by an antihistaminic drug. To provide evidence as to whether persons killed in accidents or involved in crimes were under the influence of liquor, analyses of body fluids for alcohol were made for the police in a considerable number of cases.

In six cases of suspected drowning the Auckland laboratory made determinations of the chloride content of the blood from the right and left ventricles of the heart. From the results it was established that one of the persons had been drowned in fresh water and three of them in salt water.

Flakes of paint provided evidence of identity in several motor-vehicle collisions and in a case of safe-breaking.

Other exhibits examined included a greasy textile in an arson case, a counterfeit coin, a signature for evidence of alteration, writing-paper, notornis feathers, and window glass.

OIL, BITUMEN, AND TAR

Work on these materials included the analysis of 420 samples, made up as follows: aviation fuels, 70; other fuels, 19; new lubricating-oils for compliance with specifications, 125; miscellaneous and used lubricants, 36; miscellaneous oils and related products, including Customs samples, 63; bitumens, tars, and other roadmaking materials, 107. A considerable amount of advisory and consulting work was carried out during the year, largely in connection with engine failures, for which the lubricant was frequently (and unjustly) blamed. Lack of proper maintenance is usually a more probable cause of the trouble. Work on road materials included the following: formulation of cut-back binders; blending of Australian tars with local tar oils to produce road tars acceptable to the Main Highways Board; assistance to some of the smaller gas companies in the production of road tars; failure of road oil to hold chips; and testing of tars for viscosity.

PHYSICAL CHEMISTRY

Physico-chemical methods were used throughout the Laboratory in the ordinary course of analysis and investigation. The spectrograph and the X-ray diffraction apparatus were applied to many problems. They were used to identify corrosion products, scales from boilers and cooling systems, minerals, and alloys of unknown composition, and the differentiation of different types of electrical contact metals used in telephones and of mixed stainless-steel and stainless-iron turbine blades. The spectrograph was used in testing the coatings of fluorescent lamps for the presence of the poisonous metal, beryllium, for the determination of lead in dust from a printing-works, for checking the possible presence of poisonous metals in the plating on spoons, and for the rapid complete analysis of minerals. In the search for the cause of excessive steam consumption in a timber-impregnating plant, measurements were made of the specific heat and phase changes of creosote.

Work was continued on the development of optical crystallographic techniques for the identification of minute amounts of unknown substances. For this purpose a five-axis universal stage and a monochromatic light source were set up. Methods of growing crystals for special purposes are being developed.

A very comprehensive investigation of the causes of spontaneous fires in wool was carried out, largely by physical methods, with the full co-operation of the organic chemists. Spontaneous fires in ships carrying wool have been causing heavy losses for many years, but although much research has been done in the past it has not yet been found possible to take measures that will prevent the fires. It has now been found that the film of fat which is spread over some slaughter-works' wools during their removal from the pelt is a very serious fire hazard, but the matter is very complex and much further investigation will be necessary.

METALS AND CORROSION

Analyses were made of metals and alloys for compliance with purchasing specifications and to evaluate such properties as corrosion resistance, impact resistance, fatigue resistance, and weldability.

Many instances of failure of metals were investigated, including the pitting of cylinder liners of a Diesel engine, the corrosion of copper spouting, and the corrosion in a large steam turbine. Steel joists for hydro-electric dams that had been found to be brittle were sampled at the dam site and were shown by analysis not to be in accordance with the specification for composition. A method was developed for making more efficient joins in high-voltage transmission lines. The corrosion of aluminium sheet used for building purposes has been studied and exposure tests have been made under various conditions and environments. Many inquiries on corrosion and means of avoiding it were answered for Government Departments and industrial firms.

COAL

The analysis of coal, including run-of-mine, mine-face, drill, outcrop, and industrial samples, totalling 1,754, formed a large part of the work done on coal. The drill samples, mainly supplied by the Mines Department, made up a large proportion of the total, the coal survey providing rather fewer. The industrial samples arose mainly during the work of the fuel technologists on boiler efficiency.

To assist in the difficult seam correlation in the Ohai district, a survey of the ash-fusion characteristics of Ohai coal was commenced.

Further investigations were made of some of the anomalies previously noted in the inflammability of certain coal-dusts, which were finally shown to be due mainly to variations in the dispersability of the dusts. Four new sets of apparatus for the determination of inflammability were tested and standardized for the Mines Department before being installed in the mine-rescue stations at Huntly, Granity, Dobson, and Ohai.

Work was also done on the forms in which sulphur is present in coal and in coal-gas. A new method of sulphur determination was worked out, and proved very satisfactory by comparison with three other methods.

CHEMICAL ENGINEERING

Advice was given on various chemical-engineering problems involving temperature control, dust removal, handling, pelleting, dehumidification, size reduction, distillation, and heating.

With the arrival of additional staff from Britain, active work on fuel-technology problems was recommenced. Two officers, one stationed in Wellington and the other in Dunedin, were available for consultation. Advice was frequently given, and reports were prepared on seven installations. Complete boiler trials were carried out on four installations, and assistance was given to an engineering firm in conducting a boiler test on a new installation. Corrosion and scale deposits in boilers and a serious case of corrosion in condensate-return piping were investigated.

Considerable work was done with a liquid-solid "cyclone" on the separation of different size fractions of clays.

The flow of steam from the Karapiti Blowhole was measured with an estimated accuracy of about 3 per cent., and found to be 35,000 lb. of steam per hour at the time of the test.

BUILDING MATERIALS

In addition to the work on cement, concrete, and roofing-tiles mentioned earlier, building materials handled by the Laboratory included paint, timber, and timber preservatives.

Five hundred and fifteen paints were examined, consisting mainly of exterior oil paints, and including priming coats, undercoats, and finishing coats. There were also special-purpose paints such as traffic paints and underwater paints, and general paint materials. A large number of accelerated weathering tests were made, of which 129 were carried out for paint firms.

The outdoor exposure tests of paint were continued on the five fences at Auckland, Wallaceville, Christchurch, Westport, and Earnscleugh. The test panels on these fences were inspected regularly. A trial was commenced at Westport of proprietary brands of ready-mixed oil paints, and at Auckland of various priming paints for use on *Pinus radiata* timber, both untreated and treated against borer by pressure impregnation.

Many investigations were carried out, of which may be mentioned the testing of paints for steel immersed in water on hydro-electric works, and the investigation of the staining of wallpaper laid on fibrous-plaster sheets.

At the Auckland laboratory a considerable amount of work was done on timber preservation in co-operation with the Plant Diseases Division and with the State Advances Corporation. This work has included an investigation of the differential absorption on wood of the constituents of Tanalith U solution, analyses of Tanalith and boric-acid solutions, and the development of an accurate method for the determination of fluorine in timber.

MISCELLANEOUS INVESTIGATIONS

At Dunedin an investigation was commenced into the differences between New Zealand made agar and a standard overseas agar. As plate counts on media prepared with the former are frequently lower than with the latter, an attempt is being made to determine whether New Zealand agar contains inhibiting substances.

Industrial Hygiene.—With the expansion that has taken place in the work of the Department of Health on industrial hygiene, a considerable increase in chemical work on that subject has occurred. Analytical and investigational work has been necessary in all the centres on dusts as possible causes of silicosis and lead poisoning, on toxic solvents, on cutting-oils and other potential causes of dermatitis, and on lead-containing pottery glazes. In two factories, which were melting plates from old lead batteries, measurements were made of the lead content of the air, and hazards were shown to exist in certain locations. Samples of air were taken from the vicinity of farm tractors under various working-conditions, and the amount of carbon monoxide determined.

Plant Therapeutants.—In collaboration with the Plant Diseases Division, a very large amount of work was done on insecticidal and other plant-spraying materials. Among the substances analysed were nicotine sulphate, sulphur, lead arsenate, copper compounds, oil, hydrated lime, and the newer organic materials, DDT, DDD, TMTD, Tetroc, Fermate, hexaethyl-tetraphosphate, and Parathion. Soil fumigants, such as chloropicrin and DD, were examined, and work was commenced on the analysis of mixtures of plant hormones. Further analysis were made of fruit and vegetables to ascertain the amount of poisonous residue persisting at harvest time. Parathion residues were in no case greater than 0·18 parts per million, which figure was obtained from beans which were harvested seven days after the last spraying. The selenium, arsenic, and DDT residues were in all cases less than the allowable maximum, and the mercury residues did not exceed 0·06 parts per million. Potatoes treated with DDT and BHC were examined for residual insecticide after cooking in various ways.

Geothermal Investigations.—Analyses were made of gases and water from the bores that were put down by the Ministry of Works at Wairakei to explore the possibility of obtaining power from geothermal steam. Much of the work was done to determine the effects of the steam, gas, and water on engineering plant, and especially as a guide to the location of further bores. The more fundamental scientific aspects are considered equally important, but had to be subordinated for the time being to the task of obtaining the immediately useful information.

SERVICE TO INDUSTRY

Many analyses were made for manufacturing firms, especially of metals and alloys, and in connection with corrosion problems. This work was accepted only in special circumstances, as it is not possible to provide a comprehensive analytical service. Fees were charged according to the amount of work involved. Much of the assistance requested by manufacturers was within the province of private analysts and consultants and was accordingly not accepted.

Special investigations of manufacturing problems were made on request from firms, provided that there was a prospect of solution by chemical, chemical-engineering, or bacteriological methods, and the work required could be undertaken by the limited staff that could be spared.

Several of these investigations have already been mentioned in the course of this report, as, for instance, fuel-technology problems.

GAS-TESTING

The gas-supplies of the four main centres and of most of the other main towns were regularly examined as required by the Board of Trade Gas Regulations administered by the Department of Industries and Commerce, and all gas-meters put into service were officially tested and stamped before installation at consumers' premises.

PAPERS PUBLISHED IN SCIENTIFIC JOURNALS

CORNES, J. J. S.: "Fertilizer by Fusion of Rock Phosphate with Greensand and Dolomite," *N.Z.J. Sci. & Tech.*, 1949, *30*, 250.

RAFTER, T. A.: "Sodium-peroxide Decomposition of Minerals in Platinum Vessels." *The Analyst*, 1950, *75*, 485–492.

SEELYE, F. T., and RAFTER, T. A.: "The Low-temperature Decomposition of Rocks, Ores, and Minerals by Sodium Peroxide Using Platinum Vessels." *Nature*, 1950, *165*, 317.

DOMINION PHYSICAL LABORATORY

Director: Dr. A. G. BOGLE

In February, 1951, Dr. E. R. Cooper, who had been in charge of the Laboratory since its inception, was appointed Assistant Secretary (Physics and Engineering) of the Department, and Dr. A. G. Bogle was appointed Director in his stead.

The Laboratory has five main technical Divisions, which are Mechanical Engineering (including Design, Metallurgy, and Workshops Sections), Engineering and Building Research (including Hydraulics, Engineering, Seismology, Concrete, Heat, and Fire Research Sections), Standards (including Metrology, Temperature, Radiation, Electrical Standards, Optical Design, and Physical Instrumentations Sections), Physics Research (including Nuclear Physics, Geophysics, and Mass Spectrograph Sections), and Electrotechnology (including Radar, Radio Research, Electronics, and Electron Microscope Sections).

MECHANICAL ENGINEERING DIVISION

Design

This section has been mostly employed on design work for other sections of the Laboratory and for authorities outside the Laboratory.

Development projects originating within the section have been limited owing to staff depletion. Following good results with an early model, a second fractionating molecular still has been built, and a third planned. The second model, applied to distillation of vitamin A from fish oils, has given good results. Successful test runs have been made with an ultracentrifuge, designed for 60,000 r.p.m. An overspeed test on the rotor at 66,000 r.p.m., and a bursting test on a dummy rotor at 97,000 r.p.m., have brought the main development work to completion. Minor modifications are in progress prior to despatch to the Plant Chemistry Laboratory.

Metallurgy

An extensive consultant service has again been rendered to industrial and other organizations. During the year 104 certified reports were issued. Further attention is being directed towards means of salvage of materials in short supply.

An investigation into the most suitable types of moulding-sands for foundry moulding is proceeding.

Fuze Examination.—On behalf of Army Department, 7,000 fuze units have been examined radiologically to avoid needless rejection.

Workshops

The Workshops continue to provide an important service to industry, Government Departments, and others in advice, repair, special manufacture, and original design. Heat treatment of all types of steel is still a major contribution to industrial requirements.

ENGINEERING AND BUILDING RESEARCH DIVISION

Hydraulics Research

The permanent hydraulics laboratory, established late in 1949 in one of the large stores buildings near the main laboratory, is running at full capacity, with five model set-ups.

Maraetai Penstock Model.—The purpose of the tests is to determine whether one of the Maraetai penstocks can take the whole river flow while the diversion tunnel is being plugged and converted into a spillway. Tests on the penstock are now complete, and a further series of tests on the downstream river-bed is now under way.

Roxburgh Spillway Model.—The model was planned for a study of the whole of the proposed installation at Roxburgh. The model was completed early in the year, and most of the major tests have been done. Work is still in progress on the conditions at the outlet end of the spillway channel.

Whakamaru Spillway Model.—This is primarily a study of the performance of the spillway, which at Whakamaru straddles and discharges into the diversion channel. The model was ordered last June and completed in October, the more important questions have been answered and some modifications have been made.

Lake Tekapo Control Model.—This model is for a study of the outlet control works at Lake Tekapo. The main problem lies in the effects of the sluice discharge on the shingle river-bed downstream, which is represented in the model by a bed of fine gravel in which scour effects induced by the moving water can be measured. The model was ordered in June, completed in October, and sufficient tests have been made to answer the immediate questions posed by Ministry of Works Design Office.

Engineering Seismology

Strong Motion Seismographs.—These instruments are for determining the characteristics of strong earthquakes, which affect structures. A number will be placed at different locations throughout the country in order to gather a useful amount of information in a reasonable time. A suitable instrument is being developed in the Laboratory.

Analysis of Earthquake Records.—A number of earthquakes, recorded at the Seismological Observatory on the only strong motion seismograph at present available, have been analysed. The information gained will be useful in the design of earthquake-resistant structures.

Strain-gauging.—Tests are being made on different makes of resistance strain gauges to determine their suitability for long-term strain investigations. A satisfactory technique has been developed for the protection of these gauges when fixed to reinforcing-steel in concrete. A gauge for measuring strain in concrete has also been developed and tested satisfactorily under laboratory conditions.

Measurements are being made for the Ministry of Works on the new Otahuhu Substation building by using resistance strain-gauges attached to the reinforcing-steel, strain-gauge capsules embedded in the concrete, and earth-pressure cells under the foundations incorporated in the structure.

Strain-gauging equipments permitting dynamic observations on one and on six gauges simultaneously have been installed in a trailer for use in tests on bridges and other structures.

Horizontal Vibration Meter.—A prototype instrument has been built for use in measuring the dynamic characteristics of buildings and other structures in order to assess their resistance to earthquakes.

Shaking-tables.—These are controlled vibrating tables for testing vibration equipment. A mechanically-driven table has been built and used for calibration of Hallade track-recording machines for the Railways Department. A table driven by magnetostriction is being built to measure vibrations of high frequency and small amplitude.

Heating Research

The major effort has been on the measurement of efficiency of domestic fireplaces in conjunction with local fuels, using the calorimeter room and accessory equipment completed early in the year. Results are now beginning to emerge and these indicate that the modern convection type of stove is considerably more efficient than older simple fireplaces. The use of this type offers appreciable fuel-saving and improvement in comfort.

Viscosity of Refrigerants.—The efficiency of heat transfer around refrigeration evaporators is governed by the viscosity of the liquid-gas mixture, for which no figures are available. A method, employing a novel principle, is being developed with the aim of measuring the viscosity. Initial tests with water have given promising results.

Concrete Research

Dense Concrete.—Preliminary tests on the effect of variations in aggregate grading on strength have been completed. The effects of wetting agents and soft aggregates are now being tested.

Foam Concrete.—Preliminary examination of this material, which is expected to be suitable for insulation of buildings, has commenced.

Pozzolana Concrete.—Pozzolanic admixtures can result in increased durability and stability of large concrete structures, together with a saving in cement. Preliminary investigations indicate that pozzolanic materials are widespread in New Zealand. Large samples have since been collected from several North Island deposits and are under examination.

Testing of Engineering Materials.—Foundation rocks have been tested for the Ministry of Works. Testing of *Pinus radiata* in structural sizes has continued.

STANDARDS DIVISION

The establishment and custody of standards of measurement of physical quantities—*e.g.*, length, mass volume temperature, electricity, &c.—is a statutory obligation of the Department delegated to the Standards Division. This function of the Laboratory has continued to grow during the year, and the highly specialized equipment required for this work is gradually being established.

Metrology Section.—The section has done regular linear measurements for internal and other purposes, these being restricted mostly to measurements of an engineering type. Some progress has been made in establishing interferometric techniques, and several instruments for this class of work are in course of development. A critical intercomparison of barometers from the Australian Meteorological Office and Laboratory Standards was made with satisfactory results.

Temperature Section.—The techniques associated with the calibration of liquid-in-glass thermometers are now well established, and the way is well prepared for calibrating the present standards against the standard platinum resistance thermometer on order. The thermometric scale has been established based on a group of standards recently calibrated at the National Standards Laboratory, Sydney, but locally maintained "fixed points" are used to check the calibrations. A substantial increase in the number of thermometers calibrated is reported.

Radiation and Photometry.—This new section is developing techniques and standards of radiation and photometry.

Measurements of visible radiation from the sun and the sky have been continued on a routine basis. Improved ultra-violet radiation recorders have been operated at Wallaceville, Lincoln, and Invermay. A preliminary study of the results indicates that weather conditions are a dominant factor in determining the incidence of ultra-violet radiation.

A programme of instrumentation for the assistance of biologists, particularly of the Grasslands Division, has progressed. This included the provision of a lighting system for the artificial illumination of plants in controlled-growth experiments. together with associated monitoring and recording equipment.

An 18-in. integrating sphere has been built for sampling and examining the radiation incident on the earth's surface.

Electrical Standards Section.—A senior engineer experienced in electrical standards work was appointed early in the year, and immediately brought his considerable experience to bear on the job of establishing electrical standards. Work is proceeding on the instruments that have been chosen as the starting-point of New Zealand's system of electrical standards, and at the moment the greatest attention is being given to the preparation and calibration of the standards of resistance. Techniques in this field have improved to the point where measurements of 1 part in 1 million or better are ordinarily achieved.

A universal dynamometer instrument was put into commission during the year.

Full collaboration with the Departments and organizations affected has been established.

Optics Section.—The design of a three-component collimating lens for a fast spectrograph has been completed.

Progress has been made on the establishment of techniques of optical testing, and a continuing demand for reports on lenses and other optical apparatus has been successfully met.

Physical Instrumentation.—A reliable type of frost alarm for orchard work was developed and six prototype units were given an extended and successful operational trial in Central Otago. A V/G recorder was developed at the request of the Commonwealth Aeronautical Research Council for the purpose of recording the accelerations imposed on a taxi-ing aircraft, and has given satisfactory results in laboratory tests.

A large number of pressure gauges, speedometers, loadometers, and industrial temperature-indicating instruments were calibrated as a routine service to industry and to Government Departments.

The work for geothermal power investigations is referred to below.

Calibration of Instruments.—During the year, certificates have been issued for a large proportion of some 200 calibrations carried out on instruments of standard, sub-standard, or " working " quality.

PHYSICS RESEARCH DIVISION

Nuclear Physics.—Equipment is being developed for assessing the age of carbonaceous materials from the proportion of C14 isotope present. Age determination up to fifteen thousand years is expected to be possible. Satisfactory progress is being made.

The problems associated with clinical use of radiophosphorus in New Zealand hospitals are being studied.

The use of cobalt and iridium isotopes for industrial gamma radiography is being investigated.

Construction of a variety of health monitoring and measuring instruments—laboratory monitors, radiation monitors, linear amplifier, G-M tube tester, &c.—has been completed. An improved decade scaling circuit has been developed and has proved very satisfactory in use.

Geophysics Research and Instrumentation.—The development of instruments and techniques for geothermal power investigation has constituted a major project for the Laboratory as a whole. It has made considerable demands on the Geophysics, Nuclear Physics, Design, and Workshop Sections. Two physicists have been stationed at Wairakei. The principal requirements are for measurement of temperature in boreholes and of heat flow from them. Temperatures up to 230°c and pressures of 150 lb. per square inch have been encountered and have presented serious instrumental problems. Several temperature-measuring techniques have been used, each presenting its peculiar problems and none with completely satisfactory results. Accordingly, an indexing bathythermograph of unique design was developed. The instrument is in service at Wairakei, and promises to be the most useful temperature-measuring instrument yet applied to deep-bore work. In addition, equipment has been developed for radioactivity measurements on thermal waters and gases, and a gamma radioactivity survey of the Wairakei area has been carried out.

Construction of the field laboratory, Moore's Valley, is complete, and the laboratory is in operation. The work carried out comprises testing of seismic, magnetic, and electrical instruments for the Geophysical Survey; earth current measurements, measurement of magnetic properties of rock samples to aid interpretation of geophysical surveys; and magnetic and seismic research.

Instruments have been and are being developed for the observation of frequency and amplitude of ocean waves and tides for oceanography and underwater research.

Much time has been spent in maintenance of geophysical field-prospecting equipment used in the thermal regions and on hydro-electric dam site investigations.

Mass Spectrograph Section.—This section is engaged on the construction of a mass spectrograph for use in biological and other research where stable isotopes are employed. The construction of components has been completed and they await assembly.

ELECTROTECHNOLOGY DIVISION

Radar

Microwave Meteorological Radar.—Assistance was given with the installation and setting up of the third set previously constructed by the Laboratory.

Radio Research

Ionosphere Propagation Studies.—The programme started in 1949 of simultaneous measurements of absorption of radio waves reflected by the ionosphere obliquely (in passage between Awarua and Lower Hutt) and vertically (at Christchurch) was completed. Results have been analysed and the suspected existence of an anomaly in the currently accepted theory has been confirmed.

Regular measurements of times when reception of transmissions from Radio Australia cease at night (skip times) are being continued on a long-term basis at the request of the Australian Ionosphere Prediction Service. The information assists in improving predictions.

Equipment is being constructed and assembled for observing rapid fading of signals received via reflection from the ionosphere and for the study of ionospheric winds.

A new and improved type of ionosphere sounder for routine ionospheric observations has been developed, and the Laboratory model, which was used successfully, will be used as a prototype for new equipments to replace those in use by the Geophysical Observatory, Christchurch.

Microwave Propagation Studies.—A physicist of the Radio Section, now attached to the Telecommunications Research Establishment, United Kingdom, has been assisting in the analysis of data obtained from the Canterbury Project, a New Zealand and United Kingdom radio-meteorological investigation.

A programme of routine measurements of the propagation of 3 cm. and 9 cm. radio waves across Cook Strait was completed after a year of continuous operation. Some further investigations were carried out subsequently into the causes of deep fading observed. A report to the Post and Telegraph Department on the operational reliability of those wave-lengths is nearing completion.

Medium-frequency Ground Conductivity Survey.—The aim of the survey is to permit reliable estimates to be made in advance of the coverage of projected broadcasting and radio navigational aid transmitters. It also provides a check of the coverage of existing stations. The range of frequencies measured is 200 kc./s. to 1,500 kc./s. The survey of the North Island is proceeding, including a check on any possible differences between summer and winter conditions.

Radio Research Office

This office continues to collect and correlate radio research information and to supply the Navy and the New Zealand amateur radio organization with routine predictions of usable frequencies for fixed circuits. The monthly issue of the *Cosmic Relations Bulletin* continues, the circulation list having increased to include more than 120 New Zealand and overseas authorities.

Electrical and Electronic Development and Testing

Quartz-crystal Controlled Clocks.—The investigation of very stable oscillator circuits suitable for the high-quality imported crystals has been undertaken. Two improved clocks are approaching completion.

Quartz-crystal Preparation.—Techniques are being developed and equipment selected for establishing the process of wire-mounting of miniature crystals *in vacuo* on a production scale for the Post and Telegraph Department.

Moisture-measurement Investigation.—Studies of the measurement of moisture, with special reference to primary products, have been initiated and are continuing. A small laboratory is being equipped especially for this work.

Timing Devices.—Instruments developed for purposes associated with timing include an instrument for the rapid and convenient rating of timepieces, a camera shutter timer, and several tuning-fork-controlled 50 c./s. power-supplies with output sufficient to drive seismographs in the absence of controlled A.C. mains.

Regulated Power-supplies.—Two special units were developed and constructed, one to provide 1 mA. at 3,000 v. mains supplied, and the other for use with a battery to give a regulated voltage preset between 1 v. and 150 v. for currents up to 2A.

Service and Testing.—Instruments serviced or calibrated for industry, Government Departments, and others included audio and high-frequency oscillators, thermostat, audiometers, photoelectric timer, electrocardiograph, and metal sorter.

The considerable volume of electrical testing carried out included tests of switches, plugs and sockets, fuses, circuit-breakers, water-heaters, motors, cables, and acoustic noise level.

Electron Microscope

Modifications carried out have improved the microscope performance. Its useful maximum magnification is now about 50,000. An ultramicrotome has been designed aimed at producing sections less than 1/10,000 mm. thick suitable for direct microscopic examination.

Particle sizing of zinc oxide paint pigments continues to be an important item of service to industry, while research is being continued on spermatozoa of bulls.

PUBLICATIONS

Apart from the usual test reports and certificates, the staff have compiled eighteen reports on various subjects, one bulletin, and nine articles for scientific or technical publications.

ENTOMOLOGICAL RESEARCH STATION

Director: Dr. D. Miller

GRASS-GRUB

Insect Parasites.—In the collection and shipment to New Zealand of Thynnid parasites of grass-grubs from Australia, a total of 3,300 pairs of Thynnid adults of several species were sent in the spring. These were liberated in several localities—Tauranga, Matamata, Te Miro, Foxton, Nelson, Ashburton, and Oamaru. The North Island localities were chosen to give the parasites a chance in a warmer climate. In the South Island localities more than one species of grass-grub was present, and this may assist the establishment of the parasites. In several areas where parasite liberations have been made, Thynnid cocoons have been recovered from the soil, indicating that they have bred successfully on the New Zealand grass-grub. There is as yet, however, no definite proof that the parasites are strongly enough established to maintain themselves.

Attention is also being given to investigating Tachinid and Thynnid parasites from highland areas of Victoria and New South Wales.

Parasite Worms.—Laboratory cultures of these nematodes have been kept going and good results have been secured with insectary colonizations, but the field tests have not yet been initiated.

Chemical Control of Grubs.—Promising results have been secured with DDT and benzene hexachloride incorporated in superphosphate top-dressings at the rate of 1 lb. (100 per cent.) of insecticide per acre. DDT has the advantage in cost of insecticide, which is about 6s. per acre. The treatment has its principal effect on the smaller grubs in the summer and autumn following the application, and appears to have little effect—though there is sometimes a pasture recovery—on the large grubs present when it is applied. For this reason the treatment is in the nature of an insurance against grass-grub, and will find its greatest use in areas that are attacked year after year in greater or less degree. There is evidence that the grub-proofing effect may last two years following application.

Extensive trials on a field scale have been laid down in both North and South Islands.

Experiments on the effects of dosages of up to 2 lb. of DDT per acre have not disclosed any adverse effects on earthworm populations in the soil or on the germination of grasses, cereals, and crucifers. Attention is being given to the determination of possible injurious effects on animals that graze on treated pasture.

Good results on the recovery of pasture continue to be obtained by the use of heavy rollers between May and August. Irrigation has not been found to preclude grass-grub attack.

GENERAL

Grass-caterpillar.—The benzene hexachloride - superphosphate top-dressing for control of this insect is being widely used. Some 4,500 acres were treated by farmers last year.

Manuka-scale.—Observations continue on the species of *Eriococcus* associated with "manuka blight."

Tussock-moth.—Experiments have been started in the Mackenzie country to elucidate the role of tussock-moths in the deterioration of tussock. These involve the elimination of tussock-caterpillars from the experimental areas, and a study of the effect of this on the growth and recovery of tussock as compared with that on unprotected areas.

Yellow-leaf in Phormium Flax.—Surveys have been made of the insect found on flax, with particular reference to sap-sucking insects that could be vectors of a virus disease. The most likely of these were tested in transmission tests, and one Cixiid hopper (*Oliarus atkinsoni*) has produced, in the experimental plants, leaf yellowing and root lesions indistinguishable from those of the naturally occurring disease, with a strong probability that the disease is caused by a virus. The insect will probably prove amenable to control by flooding or by insecticides.

Green Vegetable-bug.—The egg parasite imported from Australia and liberated in North Auckland was recovered in the field and was liberated in Auckland City, where the bug is now very numerous. It is desirable that the Tachinid parasite of the adult bugs should also be introduced.

Pine Horntail.—Distribution of *Rhyssa,* the parasite already established in New Zealand, has continued. The egg parasite *Ibalia* was introduced through this Station on behalf of the New Zealand Forest Service.

St. John's Wort Beetle.—The distribution of this beetle has continued. Much of the material this year was sent to the North Island and liberated on Tutsan-infested areas.

Wheat-bug.—Investigations are in progress on this insect, which is reputed to cause " sticky dough " in wheat and which also damages young cruciferous crops. Progress has been made in elucidating the egg-laying and feeding habits of this species.

Red-clover Thrips.—Progress with this insect has been mainly in the development of sampling techniques and rearing of the insect under laboratory conditions.

White-clover Case-moth.—Preliminary work has disclosed that there are two closely related species concerned, of which the second and previously unrecorded species appears to be the more important. A search is now proceeding in Europe for parasites of these species.

Diamond-back Moth.—A survey of this pest of crucifers in both Islands was made in order to assess the influence of the introduced parasites, but the pest this season was nowhere abundant enough to enable a satisfactory estimate of parasitism to be made.

Hop Insects.—A survey has been made of insects affecting hops.

Quarantine.—Assistance has been given to the Agriculture Department in the development of a more efficient plant quarantine service in New Zealand, and to the South Pacific Commission and the External Affairs Department on similar measures affecting New Zealand's Pacific dependencies.

FATS RESEARCH LABORATORY

Director: Dr. F. B. Shorland

Butterfat Investigations.—It appears that the variations observed in seasonal changes in fatty-acid composition of butterfat are closely related to the plane of nutrition of the animal. During the flush growth of pasture the oleic acid content is at a minimum and the saturated acids C_4 to C_{16} at a maximum. When the pasture growth diminishes, the oleic acid content of the butter rises, and that of the C_4 to C_{16} decreases. These changes are similar to those found by other workers in butterfats from full-fed and from starved cows respectively.

Important advances have been made in this Laboratory regarding the nature of the C_{20} and C_{22} unsaturated acids. The more highly unsaturated acids are important in connection with the onset of rancidity. In the C_{18} series it has been established that the triene acid present is linolenic acid, the main fatty constituent of pasture. It is present apparently in much greater proportions in New Zealand butterfat than in the English butterfat examined by other investigators.

For the first time it has been shown that branched-chain fatty acids occur in butterfat. This means that butterfat is not only much more complex than originally envisaged, but that long-chain branched acids occur in natural fats.

The unsaponifiable matter of butterfat has been shown to be extremely complex. From it there has been isolated—in addition to B-carotene and cholesterol —lanosterol, a triterpene, and small amounts of four other crystalline compounds not hitherto known to occur in butterfat.

Investigations on Tallow.—Complaints regarding the quality of New Zealand edible tallow have been received from Great Britain, and investigations have been made on the method of rendering and the quality of the tallow. It has been found that mutton tallow varies greatly in its keeping qualities. With a view to improving the keeping quality of the tallow, various antioxidants have

been tried and found effective. Apart from the fatty matter of the spinal cord of oxen, no naturally occurring antioxidant that is effective and yet economical has been found, while the use of synthetic antioxidants may be injurious to health. The problem is being further investigated.

The possibility of monoglyceride manufacture from tallow is being investigated, as are several problems relating to stearin manufacture, including fat hydrolyses by the Twitchell procedure.

Meat Investigations.—A start has been made to determine the nature of meat fats, which have an important bearing on the quality and keeping properties of the meat.

Miscellaneous.—Continued advice and assistance has been given to the fish-liver-oil industry. Acting on advice given by this Laboratory, the local whale-oil industry has been able to improve substantially the quality of its product.

The constitution of a new C_{16} unsaturated acid of rape leaf has been determined. The results of a number of investigations have been published during the year.

FRUIT RESEARCH STATION

Director: Mr. J. D. Atkinson

Considerable progress was made in establishing blocks of new trees to extend the experimental programmes at the four research orchards. This year the staff published five papers and has twelve awaiting publication.

Plant Hormones.—Most of the work preliminary to certification of tomato-setting and anti-fruit-drop hormones was completed. Excessive amounts of hormone, truss dipping, and spraying of whole plants increased the numbers of hollow fruit, while application direct to growing tips caused marked leaf distortion. The setting hormones ripened outdoor tomatoes somewhat earlier but did not increase yield, while stunting occurred when the whole plant was sprayed. Yield of dwarf beans was not increased by hormone treatment.

The sodium salt of 2,4-D, applied to sweet oranges after pre-harvest dropping had begun, reduced this loss by 63 per cent. without injuring the trees. Some of the dangers in chemical thinning of apples were ascertained. Hormones failed to retard blossoming of Moorpark apricots and thus reduce frost risk. Callus formation was considerably stimulated by wound dressings incorporating hormones when applied after spring growth had begun. Alpha naphthalene acetic acid increased the colour of Jonathan apples but decreased their storage life.

Plant Physiology and Orchard Management.—Some success attended field trials to diagnose several disorders of unknown origin, one being manganese deficiency of peaches, fairly common in Auckland and controllable by spraying. Judged by symptoms, some parasitic organism appeared responsible for the death of young stone-fruit trees. Despite many different treatments applied to soil and trees, no clue was obtained as to the cause of cherry-tree mortality in Central Otago, but work is continuing. As an aid to field diagnosis, the safety limits of various trace-element sprays have been determined for a range of fruit types.

Two aspects of orchard management—viz., use of permanent grass frequently mown and contour planting—are now under trial.

Tissue-test methods are being used to study levels of nutrition in a range of fruit-trees, and an attempt is being made to find out why it is so difficult to grow a tree on Northern Spy stock where one on the same stock has previously died.

Pomology.—New blocks, including the most promising rootstocks from England, were planted at Earnscleugh and Appleby, and trees were budded in preparation for completing existing rootstock trial areas. A study is being made of the effect of East Malling stocks on fruit size and storage quality in the Sturmer apple. Stone-fruit stocks are now being examined to find ones that will give improved performance in orchards, and others that will confer a dwarfing habit to speed up experimental work.

The best six of new, tested apple varieties were planted out in various districts for commercial trial, but a further large collection of potentially useful varieties is being secured, as there are still gaps in the succession of varieties at harvesting and some of those widely grown to-day are not satisfactory.

Only limited progress was made in the further search for a method of growing trees on their own roots. Striking success was obtained in invigorating stunted pear-trees by inarching, but apples did not respond and are being subjected to further trial.

Storage.—Scald on apples in cool storage was not controlled by either activated charcoal or a latex preparation, but conditions for the charcoal trial were not ideal. Optimum conditions for cool storage of Chinese gooseberries were determined, but there seems little prospect of storing this fruit satisfactorily for more than about one month.

Virus Diseases.—These are investigated in co-operation with the Plant Diseases Division. Stony-pit of pears was not transmissible to grafted scions of the William Bon Chretien variety, thus confirming American experience. A search is being made for apple varieties resistant or immune to proven virus troubles. Budding or grafting trials are in progress to determine whether viruses are implicated in several disorders of unknown origin.

Frost.—Field tests showed that bud freezing temperatures determined artificially were closely related to practice. Temperatures inside buds differed little from the surrounding air temperature. Irrigation immediately before frost did not appreciably raise air temperatures, and although continuous spraying of trees with water did help to protect a few dormant trees, it cannot be recommended because of the weight of ice formed.

Miscellaneous.—In wound-dressing trials, attention is being given to the fungus-inhibiting properties of compounds that proved suitable in other respects. Rapid death of apricot-trees was shown to be due to small amounts of fuel oil draining from firepots stacked inverted in the crotches of the trees.

GEOLOGICAL SURVEY

Director: Mr. M. Ongley

INTRODUCTION

During the year the staff of the Geological Survey has been fully occupied in dealing with problems of economic importance, such as investigations in the thermal regions, water-supply, mineral deposits—*e.g.*, sulphur and cement-making materials—engineering geology, and coal resources; and with the Regional Survey work. As far as possible a balance had to be maintained between work of immediate economic importance and the long-term fundamental regional work, as the latter provides the foundation for all the work of the Survey.

Much of the work is related to the requirements of other Departments, such as the Ministry of Works and Mines Department, and close collaboration has been maintained with these and with the Dominion Laboratory.

REGIONAL GEOLOGY

Geologists are continuing the field-work for the regional mapping of the country in North Auckland, Waikato, Rotorua-Taupo, Hawke's Bay, Canterbury, Reefton, Buller, Balclutha, Mataura, and West Southland. Each district is examined as a part of New Zealand to enable the geology of the whole country to be written. In addition, each presents particular natural resources with their own problems: in North Auckland, water-supply, cement materials, and coal; in Waikato, coal; in Rotorua-Taupo, pumice, concrete aggregate, geothermal resources, and sulphur; in Hawke's Bay, limestone and petroleum; in Canterbury, water resources; in Reefton, limestone and coal; and in Buller, Balclutha, and Mataura, coal.

SPECIALIZED WORK

Field geologists cannot work without collaboration with specialized workers in paleontology and petrology, whose findings they endeavour to apply to the field problems. The field men observe and record the relations of specimens collected in the field, and the paleontologists and petrologists identify them and relate them to the geological history of New Zealand and the world. This enables the geological picture to be presented not only in its economic aspect, but also in its scientific setting, which in turn benefits the mineral industry. Besides paleontological work on Mollusca, Foraminifera, and Ostracoda, paleobotanical work is now being done on fossil leaves, pollens, and spores, and solutions are found for hitherto unsolvable problems of the coalfields and other terrestrial formations that contain no marine fossils. Already new light has been thrown on the age of the coal-seams; seams previously correlated are now distinguished, and their sequence established, so that from the outcrop of any one seam the position of others can be inferred.

PETROLEUM

For five months, Dr. E. Lehner, assisted by Mr. R. J. L. Stephens, geologists of the D'Arcy Exploration Co., conducted an investigation of the petroleum resources of New Zealand. The co-operation of the Geological Survey was requested and reports of previous work in this field and accounts of the geology of the districts under investigation were supplied. Field inspections were organized in which Dr. Lehner was accompanied by officers of the Survey. His report summarizes the stratigraphy of New Zealand and discusses the prospects of petroleum in all the fields.

SULPHUR

Many requests for information about sulphur resources in New Zealand have been received as a result of the difficulty likely to be experienced in obtaining adequate supplies from abroad. Inquiries have referred to the possibility of producing sulphur and sulphur-bearing minerals such as pyrite and gypsum, but none of these minerals has been found in this country in such quantity as to make any significant contribution to present or future needs.

GEOTHERMAL STEAM AND WATER

Geologists have been collaborating with officers of the Ministry of Works in investigating geothermal steam and water by mapping the geology of the areas, indicating the more favourable sites to drill for hotter ground, and co-operating with the geophysicists, physicists, chemists, and engineers in procuring information concerning the nature of the phenomena, the source and amount of heat, the volume and nature of the steam, its temperature, pressure, and depth of occurrence, &c.

VOLCANOLOGY

A team of four field geologists has continued observing and compiling data on the volcanic and thermal phenomena of the thermal regions. This work is part of the programme of long-term investigation of volcanology now being undertaken as a world project; for this New Zealand offers specially favourable facilities. From the nature of the volcanic products covering the thermal regions, it is known that in recent geological time this area has been overwhelmed by flows and showers of hot tuff, ashes, and lava. A continuous record is necessary to perceive variations in the gas discharges, for the prediction of possible activity.

HYDROLOGY

Inquiries concerning problems of water-supply arising in subdivisions for farming, housing, factories, local bodies, companies, and individuals have been answered. Water-supplies have been found in Northland, Waikato, Bay of Plenty, Hawke's Bay, Canterbury, Otago, and Southland. Data on water-supply in Canterbury have now been collected for twelve years, and the relation between rainfall and water-table is established; consequently the role of irrigation in stabilizing water-supply in this area is now ascertained.

LIMESTONE

The limestones of all regions are being progressively mapped, and visits have been made to particular areas for this purpose. This year they were investigated in greater detail in North Auckland, Waikato, Hawke's Bay, Canterbury, West Coast, and Southland.

CEMENT

During the year information was supplied concerning limestone, mudstone, pozzolanas, and cement-aggregates for use in building material and the construction of dams. Ingredients for cement-manufacture abound in New Zealand, and are being utilized according to the organization of the industry, the supply of fuel, shipping, and man-power.

ENGINEERING

Dam-sites on the Waikato, the Waitaki, and the Clutha, at Palmerston North, and Blenheim have been geologically examined and reported on. Along the Waikato the rocks are weak and variable and every site requires to be studied in detail. Changes in rock, old river-channels, trachyte plugs, and ignimbrite sheets are difficult to distinguish, and have to be studied in detail. All dam-sites are checked periodically.

COAL

Most of the main coalfields have now been surveyed in detail and a general report on " The Coal Resources of New Zealand " has been written. When the work in the Waikato Coalfield is finished, the special survey of coal resources, commenced in 1937, will be complete. The services of the Geological Survey are required continuously in the coalfields.

GEOPHYSICAL SURVEY SECTION

From the beginning of the year most of the staff have been engaged in the Wairakei-Taupo area on surveys for geothermal steam investigations.

Seismic.—Refraction and reflection methods have been employed in the Wairakei-Taupo area and results have been secured with difficulty owing to the porous nature of the ground. Refraction methods are being used to trace the undermass on the Kaingaroa Plains. A survey of Lake Rotoroa (Nelson) dam site was carried out and an investigation has been made of the Lake Onoke outlet for the Wairarapa Catchment Board. After initial work carried out by the section, equipment was loaned to State Hydro-electric Department, Roxburgh, for investigation of vibration due to blasting.

Gravity.—The survey of the Huntly coal basin was completed, and the gravity meter has been employed on regional profiles across the North Island, and on regional surveys in the thermal area and Hawke's Bay. The North Island gravity data is being computed. A preliminary report on skeleton stations is being prepared for publication. The survey party has been fully occupied surveying and levelling stations in advance of the gravity party.

Drilling.—Apart from the normal shot-hole drilling, a hole was put down for a heat supply for Wairakei Hotel, and both rigs were engaged for a large part of the year on exploratory drilling at Wairakei.

Magnetic.—Surveys were completed of the Wairakei and Rotokaua areas and a reconnaissance survey of Parariki dam site. Surveys around Taupo township are continuing.

Dam Sites.—Owing to the priority given to geothermal steam investigations, little work has been required on dam sites. Reports were furnished to Ministry of Works on Wairarapa No. 7 site and Lake Rotoroa (Nelson).

Geothermal Project.—The section contributed substantially to an interim report, made to the Ministry of Works in December, on the shallow drilling area at Wairakei. Detailed results of seismic, gravity, and magnetic methods were given.

Conference.—Members of the staff attended and presented papers at the New Zealand Geological Survey, Geophysical, and Coal-mining conferences.

PUBLICATIONS

In the year ended 31st March, 1951, the Geological Survey issued bulletins on "The Limestone Resources of Southland" and "Additional Lower Pliocene Mollusca from Otahuhu," and prepared bulletins on: "Tertiary and Recent Ostracods of New Zealand," "Permian Fossils from Southland," "The Geology of Geraldine," "The Geology of Ohai-Nightcaps Coalfield," "The Geology of Bruce Bay - Haast River," and "Early Tertiary Penguins of New Zealand."

The following have been written and are awaiting publication: "The Geology of Kaingaroa Subdivision," "The Geology of Wanganui Subdivision," "The Geology of Dannevirke Subdivision," and "The Coal Resources of New Zealand."

Ten bulletins have been written revising the geology of the west coast of the South Island.

In the following districts the field work is finished and the bulletins are being written: Mangakahia (North Auckland), Waimate (South Canterbury), Kaitangata Coalfield, Ohai Coalfield, and West Southland.

Cyclostyled reports have been issued on coalfields and water-supply.

Geologists are investigating: Kaikohe Subdivision, Huntly Coalfield, Wairakei, the thermal regions, South Hawke's Bay, Canterbury Plain, Reefton Coalfield, Mataura, and Hokonui.

GEOPHYSICAL OBSERVATORY, CHRISTCHURCH

Director: Mr. J. W. Beagley

Extensive programmes of continuous recording, analysis, and distribution of basic geophysical data have been maintained at the central Observatory in Christchurch and its branches—Apia Sub-Observatory, Rarotonga, and Campbell Island stations. These data, obtained in accordance with international standards, assist in the solution of world problems related to terrestrial magnetism, the ionosphere, cosmic radiation, seismology, and oceanography. As well as providing essential links in the world-wide network of continuously recording stations, this organization has also undertaken research into local geophysical problems.

RECORDING AND RESEARCH PROGRAMMES

Terrestrial Magnetism.—The operation of magnetic variometers at Apia has continued and the programmes of absolute observations and data analysis have been maintained. Apia magnetic and meteorological results have been completed up to the end of 1948 and the majority of the volumes published and distributed. K-indices, character figures, and details concerning sudden commencements and solar flare effects for both Apia and Amberley have been forwarded monthly to De Bilt, and research into the relationships of disturbances has been advanced. The measurement and analysis of Amberley magnetic data has continued. During the year the K-indices of geomagnetic activity for the years 1932, 1933, 1937, 1938, and 1939 were derived from the Amberley records, while the figures for 1932 and 1933 were obtained from Apia magnetograms. This information was requested for the International Union of Geodesy and Geophysics.

A close examination of mean values for all magnetic elements at Amberley and Apia since these stations were established has been made. The need for frequent intercomparisons of magnetic standards is very clearly shown by this work. With modern absolute and relative magnetic equipment coming to hand in the near future, periodic checks between Apia and Amberley standards will be made to discover any drifts that may be taking place.

Progress has been made in the study of the lunar semi-diurnal wave in magnetic elements at Amberley. Work on Z is nearing completion, and will be followed by investigations into H and D.

The Ionosphere.—In addition to the summarized information obtained from the Lincoln, Rarotonga, and Campbell Island recorders and forwarded monthly to the various prediction centres, full hourly value sheets were sent to interested organizations. Additional transmission curve readings were taken from the Lincoln records and supplied to Dominion Physical Laboratory in connection with their radio-path investigations.

Minor modifications to give clearer records were made in the sweep- and height-marking circuits of the J28 recorder at Lincoln.

A double delta aerial has been constructed at Godley Head. Records from Godley Head can now fill any gaps in Lincoln recordings for all layers but sporadic E, which shows marked local changes. The single-frequency ionosonde recorder was installed in the Botanic Gardens.

Two-minute frames of ionospheric conditions at Lincoln were obtained during the period of the solar eclipse of 8th March, 1951. Preliminary analysis of the data has revealed interesting effects.

Broad-pattern magnetic ionospheric disturbance relationships have been investigated by means of Amberley K-indices and the newly developed Lincoln I-index, yielding results in agreement with investigations at other localities.

Cosmic Radiation.—The Carnegie Institution Compton-Bennett ionization chamber has been continuously operated and data forwarded to Washington. A programme was instituted for the systematic examination of all the Ilford nuclear research plates which have been exposed at varying altitudes on New Zealand mountains and in an aircraft. As progress in examination of plates can only advance at the rate of 1 cm.^{2} per half-day, attention has so far been confined to star populations. Consideration has been given to the exposure of some plates suspended from balloons at altitudes exceeding 60,000 ft., and equipment has been developed for this purpose.

The MU2 cosmic-ray intensity recorder was placed in continuous operation at the beginning of 1951. Continued measurements to determine the diurnal variation in the north–south directions are being made.

OTHER ACTIVITIES

Oceanographic work—tidal observations, measurement of sea densities and temperatures—and seismology have been continued at Apia Sub-Observatory. Seismological bulletins have been issued quarterly, while air letters of preliminary earthquake readings have been despatched to New Zealand observatories as well as observatories in America and Australia. The United States Coast and Geodetic Survey has been advised of details of strongly recorded shocks. Climatological work at Christchurch has been maintained.

An earth-current recorder on loan was installed at Amberley, and data obtained will be investigated for effects that may be associated with tidal movements off the coast there. This work is allied with the investigations being undertaken to determine the lunar variations in the earth's magnetic field at Amberley.

Inspection visits were paid by the Director to Apia Sub-observatory and to the Rarotonga Ionosphere Station. Post and Telegraph Department operators chosen for Campbell Island service were given their usual tuition in ionospheric work.

GEOPHYSICAL OBSERVATORY, WELLINGTON

Director: Mr. W. M. Jones

From the 1st April this Section will be renamed the Oceanographic Observatory.

The staff is collecting data and examining problems of local physical oceanography. Except for some investigations that can be made from shore, the Observatory must obtain data by arrangement with naval, merchant, and fishing vessels, some of which have been supplied with instruments. The co-operation of the Meteorological Office in making available for study certain material is also of considerable help. It is inevitable, therefore, that the collection of data is somewhat unsystematic.

Wave Studies.—A wave-recorder was installed at Karoro, Greymouth, with the assistance of the Post and Telegraph Department and the Greymouth Harbour Board in the laying of 2,000 yards of submarine cable. Continuous

wave records were obtained for three months, after which the insulation failed. The records are being examined, and studies are proceeding on the estimation of distances of origin, relations to weather conditions and to microseisms, and the frequency of occurrence of waves of different heights in the wave-patterns.

The daily reports to the Meteorological Office of surf conditions are also being examined for a statistical comparison of different parts of the coast in respect of sea roughness at different seasons.

Sea Temperatures.—A bathythermograph has been lent to "Discovery II" for work on temperatures down to 900 ft. in Antarctic waters, another one to H.M.N.Z.S. "Lachlan" for use on the hydrographic survey, and another, measuring to 200 ft., is being used from launches in Cook Strait. Two surface thermographs on frigates, and three placed by the Meteorological Office on merchant vessels, are recording surface temperatures. In addition, several thousand thermometer readings by ocean-going and coastal vessels are being received yearly, plotted, and analysed. Observations over several years are necessary to cover the effects of seasonal, annual, and other variations, some interesting features being revealed—for example, the presence of areas of colder water near the Three Kings, Farewell Spit, and Cloudy Bay; the attainment in 1950 of minimum temperatures a month or two earlier in southern coastal waters than in northern; higher temperatures than the general average in 1949 in the ocean waters around New Zealand; and abnormal gradients such as a rise of several degrees in going north past Castlepoint. It is apparent that these features may have important influences on the distribution and growth of marine life.

Salinity of Sea-water.—Together with temperature data, chemical composition is important in the study of the movements of water masses and their relations to biological matters. Some hundreds of samples were collected by H.M.N.Z.S. "Lachlan" in the Cook and Foveaux Straits areas, and arrangements are in hand for collections by other vessels. The analyses are being made by the Dominion Laboratory. The results from Cook Strait waters so far indicate considerable variations, possibly seasonal, in the salinity.

Currents.—Trials of the indication of offshore currents by records of the potential differences between two electrodes on shore were made at Greymouth and Te Horo. In both cases semi-diurnal oscillations, attributable probably to tidal currents, were evident. Other disturbances on the records were associated with magnetic disturbances recorded at Amberley, and the electrode recordings are now being made there by the Geophysical Observatory to relate more closely the two effects, and to see whether any semi-diurnal effects are attributable to tidal currents off the east coast.

Microseisms.—Work has continued on the relations of microseisms, recorded at Wellington and Christchurch by the seismographs, to weather and surf conditions. A close similarity in dominant periods and amplitudes at the two stations is often recognizable, and can be taken as an indication of distant origin, while microseisms of local origin do not appear to be transmitted very far, and affect one station predominantly or exclusively. Attempts are being made to correlate the development of microseismic storms with the wave-patterns recorded at Greymouth: this may be possible when both have originated from a distant cyclonic storm and no local complications are present. If so, the time-lag, perhaps of several days, between the respective arrivals can give a measure of the distance of the originating area.

GRASSLANDS DIVISION

Director: Mr. E. Bruce Levy

PLANT-BREEDING

Breeding-work is being continued with rye-grasses, cocksfoot, timothy, white clover, and red clover. To explore the possibilities of producing a long-rotation rye-grass intermediate in growth characteristics between short-rotation and perennial rye-grass, a series of crosses has been made between selected plants from these two parents.

The variation in *Lotus uliginosus* is being studied as a preliminary to breeding a strain with improved establishment, productivity, and competitive ability. Inter-specific crosses between *L. uliginosus* and *L. corniculatus* are being made to determine the possibilities of producing a *Lotus* strain suited to the drier country.

To ensure a ready identification of white-clover plants developing from over-sown seed, a line has been produced with no marking on the leaves.

Perennial rye-grass plants of good agronomic type and apparently resistant to blind-seed disease have been produced, but much further work is required to determine if this resistance is retained in the field. In artificial inoculation with this disease the degree of infection decreases rapidly with increase in the period between flowering and inoculation.

STRAIN ECOLOGY

Yield Trials.—Over a four-year test of rye-grass and white-clover mixture the Division's nucleus perennial rye-grass has yielded 41,000 lb. of dry matter (pure perennial rye-grass) per acre, compared with 26,000 lb. from the most vigorous of the Welsh Plant Breeding Station's selections. Our selections exhibit much earlier spring growth and less winter dormancy than selections from other parts of the world.

Techniques for Strains Measurement.—In a measurement trial of rye-grass strains it has been found over a three-year period that the more versatile and more widely applicable method of mowing, with a proportional return of suitable artificial fertilizers, gives similar yields and pasture composition to the method of stock-grazing, with proportional return of dung and urine.

Strains Selection.—In a collection of strawberry clovers, several strains have proved superior in leaf production to the majority of commercial samples. One named " Palestine " is outstandingly good in the winter months.

Seed Certification and Nucleus-seed Production.—Approximately 9,000 plots were sown this year as part of the seed-certification scheme, and the usual quantities of nucleus seeds were distributed.

PASTURE ECOLOGY

Influence of Clovers and Fertilizers on Pasture Growth and Composition.—After four and a half years' test, the grazing section of this trial was ploughed up and sown to rape. Previous differences in herbage production were paralleled in the first cut of rape but not in the second or final cuts. Italian rye-grass has now been sown to determine the rate of disappearance of fertility.

The mowing series indicates that the sulphate as well as the phosphate in superphosphate stimulates growth.

Grazing Management.—Rotationally grazed pastures gave greater production than continuously grazed pasture up till November, but heavy invasion of the former by grass-grub reversed the position.

Clover Establishment in Mixed Pasture.—Close grazing during the first six months of the pasture's life was again shown essential to good clover establishment. In the first six months, pastures spelled to 9 in. outyielded those grazed at 3 in. but by the end of a further six months the position was reversed.

Bloat Control.—Bloat has been successfully controlled on several farms by intensive break-grazing of dangerous pastures. High production can be maintained if the pasture is dominated by a vigorous and palatable growth of short rotation rye-grass, but is more difficult if the dominant grass is unpalatable type or very fibrous. With this method of control in mind, some farmers have changed from perennial to short rotation rye-grass.

Other Trials.—These include further studies of earthworms in the fertility cycle, effects of different types of phosphatic fertilizers at high nitrogen levels, nitrogen fixation capacity of various pasture legumes, and a collaborative study (see Plant Chemistry Laboratory report) on improved methods of pasture establishment. There has been no appreciable change in relative production figures from the trial in which different grassland management systems are being compared.

HILL-COUNTRY PASTURE IMPROVEMENT

At the Te Awa Experimental Area the closely grazed blocks continue to produce more than the rotationally grazed blocks, but this is thought to be due to inadequate subdivision of the rotational blocks. These have now been subdivided and the stock appears more thrifty. The most marked feature of the whole experimental area has been the rapidity with which carrying-capacity has increased under the management conditions applied.

Detailed trials have been laid down at Te Awa and Gisborne to study the many factors involved in clover establishment—*e.g.*, bird and slug damage, height of grazed pasture before and after sowing, &c.

From the tree-planting experiments it would appear that the poplar group as a whole is best, with planes and sycamores as the next most useful species for spaced hillside planting.

In the gully control work there has been complete failure to grade and re-grass valley bottoms in order to provide a stable waterway. The large debris dam in Gully No. 1 has held successfully and recently has been lifted a further 2 ft. In Gully No. 2, however, concrete spillways are being erected, with mass plantings of trees in the valley bottom.

Collaborative work is being maintained with the Soil Conservation Council and the Rangitikei Catchment Board.

In sowings on flood sediments on the Gisborne flats it was found that early sowings were most successful and that the outstanding plants for this purpose were short-rotation rye and Italian rye.

GREENKEEPING RESEARCH

(In conjunction with the New Zealand Golf Association and New Zealand Bowling Council)

Detailed work at Hokowhitu has been continued, and, in addition, new studies have commenced to determine the accuracy of various sampling methods on these plots for yield and botanical and chemical composition of the herbage, and to determine the effect of different soil acidity levels on germination of brown-top and Chewing's fescue.

SUBSTATIONS

The major lines of investigation at Palmerston North are repeated under different climatic conditions at Lincoln and Gore Substations, and it is clear that the principles laid down as a result of work at the home stations are generally applicable.

Gore.—In the trial comparing different farming systems it has not been found possible to provide enough winter feed from special-purpose pastures, but the latter have been most valuable during the past dry summer. The increase in production on a grass-clover sward has been doubled by the use of lime and superphosphate. Winter and spring production on rotationally grazed pasture is 100 per cent. and 50 per cent. higher respectively than on continuously grazed pasture. The bred strains of grasses and clovers continue to outyield strains derived from other sources.

Lincoln.—Cocksfoot-seed production is markedly affected by applications of sulphate of ammonia in both autumn and spring. An increase of more than 300 per cent. was obtained by 6 cwt. of sulphate of ammonia, half applied in the autumn and half in the spring. The uptake of phosphorus from different phosphatic fertilizers at high nitrogen levels shows marked differences as between superphosphate, North African phosphate, and basic slag plus superphosphate at the end of the first year.

INFORMATION BUREAU

Officer in Charge: Mr. N. A. Marris

PUBLICATIONS

Journal of Science and Technology.—The position regarding the *New Zealand Journal of Science and Technology* has improved considerably during the past year, and it is anticipated that it will be up to date by June, 1951, with the issue of the first number of Volume 33. Arrears have been overtaken by arranging with the printer to have several issues printed by other firms on a sub-contract basis. This has involved certain difficulties. It has been necessary to page each issue separately, it has not been possible to use the same type throughout, and some of the larger tables have been specially typed and line blocks made direct from these. These disadvantages, however, are small compared with the advantage of having the *Journal* up to date and thus being able to publish results of research work much more promptly than has been possible during the past few years.

Bulletins.—The following bulletins have been published: D.S.I.R. 98, "Introduced Mammals of New Zealand," by K. A. Wodzicki; D.S.I.R. 99, "The Poisonous Plants in New Zealand," by H. E. Connor; and D.S.I.R. 100, "Catalogue of the Diptera of the New Zealand Sub-region," by D. Miller. Geological Bulletin 49, "Limestone Resources of Southland," by R. W. Willett. Palæontological Bulletin 17, "Additional Lower Pliocene Mollusca from Otahuhu," by C. R. Laws. Soil Bureau 2, "Soils and Agriculture of Westland," by H. S. Gibbs, A. D. Mercer, and T. W. Collie. In addition, Nos. 3, 6, 8, 9, 10, 11 of the "Cape Expedition" series have been published.

CENTRAL LIBRARY

Early in 1951 the Central Library moved into much larger quarters, which should meet requirements for the next five years. A small reading-room is now available, with the major scientific indexing and abstracting periodicals on open shelves. It is hoped to attract, train, and build up a competent staff able to give the quick specialized service required of a technical library.

As a means of providing a solid core of professional scientific librarians in the Department, a scheme for male technical trainees to take a degree and to receive intensive in-service training in the literature of science is at present being considered.

During the year the amount of lending and borrowing by the Central Library for Head Office and branch staffs again showed an increase. The number of publications ordered and received by Head Office and on behalf of branches also rose sharply.

TECHNICAL INFORMATION SECTION

Advisory Service.—This Section dealt with 650 major inquiries during the year. Most of the inquiries were from manufacturers, but 190 came from Government Departments and local authorities. Some 80 letters of appreciation show that the service is increasingly appreciated in industrial and official circles. The Technical Information Officer keeps in close touch with the professional staff and with the Scientific Liaison Officers in London, Washington, and Melbourne. Good liaison has been established with other information bureaux, the technical staffs of private firms, and other organizations. Most major inquiries have been answered by individual letter, but frequently recurring questions are answered by previously prepared circulars.

The *Industrial Bulletin* is published jointly with the Department of Industries and Commerce, and contributions to it are received from the New Zealand Standards Institute and the Health Department. The Department's section of this bulletin is now specializing, in different issues, in subjects of current importance—*e.g.*, building research, chemistry and plastics, food, metals, &c. Over 300 requests were received for the originals of abstracts published in the *Bulletin.*

Abstracts.—Over 300 abstracts of articles in scientific and technological periodicals were prepared during the year, most of them for inclusion in the *Industrial Bulletin.*

Translations.—Scientific papers and other documents in foreign languages were translated as required; certain abstracts published in the *Industrial Bulletin* were made direct from articles in foreign languages.

Photo-copy Service.—Over 10,000 pages were copied to meet requests from departmental officers and others.

PUBLIC RELATIONS

Press Publicity.—Press releases for general, restricted, and exclusive issue have continued, and photographs sometimes supplied; interviews with press representatives have been arranged; and information has been supplied to inquirers.

Films.—A few additional films, either as gifts or on loan, have been obtained and have been lent to branches, other Departments, and the University colleges.

Broadcasting.—A number of individual broadcast talks have been arranged; most of these have arisen from the issue of press releases.

Displays.—As part of the Government court, both a large stand and a photographic display were shown at the Canterbury Centennial Industrial Fair, and these were restricted to material from the branches situated in Canterbury. The Department also had a float in the "Hundred Years of Progress" procession at Christchurch. A large stand with framework was allotted to the Department for the Wellington Industrial Exhibition, and

material for the display was supplied and assistance given by the Dominion Laboratory, the Dominion Physical Laboratory, the Geological Survey, and the Fats Research Laboratory. The whole display was arranged by the Staff of the Department.

General.—The circulation of press cuttings has continued. Information has also been circulated to branches, other Departments, University colleges, and other organizations.

PHOTOGRAPHIC SECTION

The range of work undertaken for the branches by this section has showed a further increase.

A small projection room has been fitted up and is in steady demand for exhibiting 16 mm. films and colour slides to officers of the Department.

The field photographer has visited the Crop Research Division at Lincoln, Magnetic Observatory at Christchurch, Geothermal Research Unit at Wairakei, Entomology Division at Ashburton, and the Fruit Research Station at Alexandra.

Other services to the branches included photographing delicate leaf-fossils (photographs sent to Sweden), making map reductions to precise sizes, making glass measuring-grids, and reproducing oceanographic trace charts.

General photocopy work, preparation of Gestefilms and of lantern-slides, and developing and printing work for field officers were also carried out.

MAGNETIC SURVEY

Director: Mr. H. F. Baird

Magnetographs.—Commencing their fiftieth year, photographic recorders (magnetographs) at Amberley gave continuous traces of magnetic elements—*i.e.*, horizontal force, vertical force, and declination (variation of the compass). These records are New Zealand's basic data-lines to which all its magnetic measurements must be related. Measurements embraced disturbed navigation conditions, regional air- and land-based magnetic surveys, and international researches of theoretical as well as practical nature—*e.g.*, relationship of radio fade-outs with magnetically disturbing ionospheric currents. Quick-run records were taken through the solar eclipse on 8th March, 1951.

Land Magnetic Survey.—To keep necessary check on the change in magnetic elements, field-work has continued from Auckland to Southland. Work in the geothermal area was directed towards obtaining undisturbed magnetic values from sedimentaries occurring amongst igneous formations of greater iron content. Success followed co-operation with officers of the Geological Survey. The southern observations increased accuracy of navigation charts for defence, maritime, and increasing commercial aviation requirements.

Aeromagnetic Survey.—Advance in magnetic operations came by the use of an air-borne magnetometer, which, flown co-operatively with the R.N.Z.A.F. in a Miles Aerovan, has by its speed and economy revolutionized the ways of locating magnetically disturbed geological formations. Continuous records made at 100 m.p.h. must be related to Amberley traces through land-based stations that are some forty miles apart, otherwise control of operational sensitivities is inadequate. Most of the work has been in flying a close gridwork of lines over an area that the Geological Survey are investigating for possible economic use of geothermal steam, but background checks necessary for relating that small area to an adequate general network have come from flights between Akaroa and White Island. Many areas of magnetic disturbance over land have been found,

and flights over the sea have revealed strong disturbances near D'Urville Island, with lesser ones under Golden Bay and over Mernoo Bank, which is submerged some 120 miles east of Lyttelton. The recorder so far used measured only magnetic total force. Three-component recording, when available, will permit not only continued geological investigation, &c., but better preparation of navigation charts over ocean routes.

Magnetic Charts.—This branch as usual prepared the annual navigation charts published in the "New Zealand Nautical Almanac and Tide Tables" and in the "New Zealand Air Pilot and Flight Information Manual." For the latter, New Zealand's responsibility under the International Civil Aviation Organization requires that our navigation charts cover the area from 20° N. to 60° S. between 150° E. and 150° W. Information was also supplied to British and United States hydrographers. The printing of the isomagnetic charts epitomizing the recent new magnetic survey of New Zealand is completed and the text in hand.

Seismology.—The three-component set of Galitzin seismograph recorded moderate to strong distant earthquakes satisfactorily, on occasions permitting deduction of directions as well as distances of origins. A short-period Wood-Anderson seismometer gave many good records of earthquakes within New Zealand when not too strong or too near. A working model of a Benioff type short-period vertical seismometer was constructed which picked up some deep focus waves not within the range of the other recorders. The vertical Galitzin seismograph could not be sufficiently desensitized to cope with strong movements such as those from recent earthquakes in North Canterbury. Some less sensitive type, preferably one tripped into action by the earliest wave, would be required. The area of damage in North Canterbury was visited twice and the damage collated with that in 1901 as described by the late Mr. A. McKay, and by Mr. G. F. Allen.

OCCUPATIONAL PSYCHOLOGY RESEARCH SECTION

Officer in Charge: Mr. Dermot Straker

In the application of psychology and related sciences to occupational problems, the Occupational Psychology Research Section carries out research investigations into psychological aspects of employment in New Zealand, and maintains contacts with psychological organizations overseas. In order to acquire data for researches, personnel advisory and servicing work is undertaken on behalf of the Armed Forces. Information about modern trends and techniques in handling human employment problems is provided to industry and commerce through personnel advisory services (taken over during the year from the Department of Labour and Employment), but shortages of staff in effect limit these facilities to the Wellington area.

RESEARCH

Armed Forces.—Owing to manning difficulties in the Forces, the main research efforts of the two available professional officers had to be diverted from industry. A study was made of man-power shortage in one of the Services, and a further investigation into methods of assessment of personnel is in progress. Data collected about their recruits under the Compulsory Military Training Act, 1949, by the three Services are being analysed, and it is hoped that some of the findings may be passed on to educationalists and employers in the near future.

Management Problems.—A guide to employment interviewing and other psychological techniques of management is in course of preparation for the information of personnel officers and other supervisors exercising a personnel function.

Dairy Industry.—A short survey of personnel problems in dairy factories in South Taranaki was carried out in co-operation with the Dairy Research Institute. As a result of this survey it was possible to make recommendations designed to reduce physical effort at certain stages of cheese manufacture. It seemed likely that staffing difficulties in some of the factories visited were due to factors such as housing shortages and discontinuity of employment rather than to physical working conditions, and it is proposed to follow this matter up when the services of additional professional officers can be obtained.

SERVICE

Vocational Consultations.—Candidates for supervisory posts or for apprenticeships were interviewed on behalf of industrial firms, and individual employees who were finding difficulty in adjusting themselves to their working conditions were assisted.

Public Service.—At the request of the head of one Government Department a survey was carried out, in conjunction with the Occupational Medicine Division of the Health Department, of the attitudes of staff to their conditions of employment. As was to be expected, competition from other employers with modern working-places and flexible scales of remuneration was found to be a principal cause of staffing difficulties.

Armed Forces.—The Section continued to exercise technical supervision over the selection procedures used by the Air Force and Navy with national service candidates, and trained additional naval personnel in assessment techniques. A member was provided for Selection Boards dealing with aircrew candidates for the Air Force, and with cadet and cadet-midshipmen candidates for the Navy. The Section also took part in the selection of aircraft apprentices for training in the United Kingdom.

LIAISON, EDUCATION, AND INFORMATION

A considerable amount of information was received from overseas sources. In particular, the Admiralty and Air Ministry provided aptitude test materials and advice in connection with the selection of recruits for the Navy and Air Force, while the Panel on Human Factors Affecting Industrial Productivity sent out reports and publications relating to the waterfront industry.

Help was again given to a number of University students on the choice of topics for theses in applied psychology. Six students were given practical experience during the long vacation, when they carried out a large amount of statistical computation towards the validation of personnel selection procedures.

The Section was represented on a working party set up by a meeting representative of potential employers in industry and the Government services to examine employment opportunities for young graduates from the University psychology departments.

As in previous years, information was given to inquirers about such matters as layout and decoration of plant, the design of equipment, the use of music, and the keeping of personnel records. Lectures on psychological aspects of personnel management were given to audiences of managers and foremen, and to courses for Government inspectorship trainees and for officers of the Armed Forces. Firms interested in the appointment of personnel officers were assisted in their search for suitable candidates. Several personnel officers used the facilities of the Section to acquire information about overseas developments in personnel practice.

PLANT CHEMISTRY LABORATORY

Director: Dr. J. Melville

Nitrogen Metabolism in Plants.—Work on this project, which is concerned with the synthesis of leaf protein from nitrate and ammonia derived from the soil, has been continued, with further study of the amino acids in leaf sap by microbiological and chromatographic methods. The sum of individually estimated amino acids by such procedures amounts to only 70 per cent. of the total amino-nitrogen as determined by the Van Slyke nitrous acid method, and it is probable that the latter gives results that are too high.

By use of similar techniques but with different extraction procedures, the peptides (which form a link between proteins on the one hand and amino acids on the other) are being investigated. Contrary to the generally held opinion, they form an appreciable portion of the water-soluble nitrogenous constituents of the leaf.

The variation in different organs of soluble nitrogenous compounds of a legume, lupin, has been studied. Marked increases in amide-N and amino-N in the nodules and the tops were observed shortly after pods were formed, while considerable concentrations of urea were found in the nodules.

The Nitrogen Cycle in Pastures.—The urine from grazing animals exerts a marked differential effect on the pasture species, grass growth being stimulated and clover growth retarded. Part of this effect on clover may be the result of the shading by increased grass growth, but evidence has been obtained that urine contains substances that inhibit clover growth. It has been found that the seeds of grasses, clovers, and many weeds are killed by urine treatment, and that clovers are much more sensitive than grasses. It has also been demonstrated that root growth of germinating clover-seeds is retarded by sheep or cow urine at dilutions as great as 1 in 300 to 1 in 1,000. At dilutions of 1 in 20 the roots are killed. There are indications that urine application to established clover plants injures the root tips. Further work has shown that probably two unidentified substances present in urine exert inhibitory effects.

Ruminant Digestion.—A study is being made of the micro-organisms responsible for digestion in the first stomach of sheep, and of the influence of different pasture species, at different stages of growth, on the rumen population and on the biochemical changes produced. A detailed study has been made of the mechanism of propionic acid production in *Clostridium propionicum*, using the stable carbon isotope C_{13}. The final results await analysis by the mass spectrograph. The relationship between succinic dehydrogenase and cytochrome$_b$ has been determined, using an organism isolated from the rumen Studies have also been made on the intermediate steps in the oxidation of propionic acid.

Seed Research.—The work reported last year on the relationship between degree of maturity of white-clover seed and quality, and on the effectiveness of the tetrazolium staining method for determining the viability of dormant ryegrass seed, was completed.

In collaboration with Grasslands Division, a method has been developed for extracting dormant seed of legumes from soil samples, and a survey has been made of the occurrence of such seeds in a wide range of pasture soils. Large quantities of clover and other leguminous seed have been found in certain areas.

A study has been made of the anatomy and physiology of the seed coats of clovers and other legumes with a view to obtaining a better understanding of the dormant condition of these species.

In collaboration with the Grasslands Division and with Massey College, an investigation is being made of the possibility of drilling pasture seed and fertilizers together on new pumice land; and of the effectiveness of this procedure in producing evenness of seed distribution, increased numbers of established seedlings, and enhanced rate of seedling growth.

Seedling Growth of Pasture Species.—Using subterranean-clover seed studies have been made of the effective temperature and light conditions on the early growth of seedlings. Seedlings growing in the dark in the presence of nutrient salts, as compared with those growing in distilled water, were found to have a greater rate of total respiration, to utilize more rapidly the foods stored in the cotyledons, and to increase more rapidly in fresh weight, with growth particularly in the hypocotyl. The uptake of nutrient salts was very rapid, the ash content rising in the seed from about 3·5 per cent. to 13 per cent. during one week's growth in the dark.

In a temperature-controlled cabinet with artificial light, rates of growth were obtained fully comparable with those obtained outside in the autumn. Under conditions where light intensity was limiting growth, an increase in temperature was found to increase the rate of formation of leaves without increasing greatly the rate of accumulation of dry matter.

Microbiology.—An investigation of the possibilities of whey and whey paste as a nutrient medium for industrial fermentations has been made. The solubility and foaming properties of the whey proteins have also been studied, and it is considered that more economic methods of whey-paste utilization could be formulated.

Forage Crops.—The branch laboratory at the Crop Research Division has made a study of the vitamin C content of potato varieties, with particular attention given to the losses in storage. (See under Crop Research Division.)

Food Research.—A start has been made with a study of the effect of peroxidase on the keeping-quality of dehydrated vegetables. Incomplete inactivation of this enzyme has been associated with a short storage life and a generally unsatisfactory product, but it is not definitely known whether this enzyme is responsible for the deterioration, or whether other enzymes which are inactivated by similar treatment are involved.

Minerals in Pasture.—Analysis of herbage from the various trials conducted by the Grasslands Division has been continued.

PLANT DISEASES DIVISION

Director: Dr. G. H. Cunningham

During the year the Division maintained its advisory services to Government Departments, industry, growers' organizations, and the public. For the Department of Agriculture alone some 940 plant specimens were examined and advice was given on the identity and control of the pests or diseases present.

Specialist officers provided information on diseases and pests to assist the Department of Agriculture in formulating plant-quarantine regulations, and an officer of the Division took part in a conference arranged by the South Pacific Commission with the objective of applying quarantine more effectually in the South Pacific area. Progress was made in establishing a plant-quarantine station near Papatoetoe.

Certification of therapeutants continued to provide growers with information on materials that are safe to apply and give the most efficient control. The scheme was expanded to give more precise information about the diseases and pests against which certified materials may be used.

A record quantity of lucerne nodule culture was supplied to farmers sufficient to treat 389,600 lb. of seed.

The Timber Preservation Section's work on diffusion treatment of tawa to protect it from the very serious *Lyctus* borer is being extensively applied by industry, and in the near future all tawa coming on to the market should be adequately protected.

The Division was represented in a team of research workers organized by the Medical Research Council of New Zealand to investigate insect transmission of the tropical disease, yaws, in Samoa.

During the year the staff submitted forty-four articles for publication, as well as preparing most of the manuscript of a comprehensive book on " Plant Protection " for the Education Department. An up-to-date list of plant diseases present in New Zealand is awaiting publication, a list of insects of economic importance and a book on " Virus Diseases of New Zealand " are in course of preparation, while lists of the major overseas diseases and pests that should be excluded from New Zealand were drawn up.

ENTOMOLOGICAL INVESTIGATIONS

Resistance of Plants to Insect Attack.—One of the main problems under study is the resistance of brassicas to aphids, and two swede varieties were found showing some resistance.

Control of House-flies.—The aim is to improve control methods and examine insecticides so that certification could be introduced if necessary. Resistance of strains of house-flies to DDT varied by as much as eighteen times, but both resistant and susceptible strains were equally sensitive to pyrethrum. Significant differences were found in phases of the life history of the two strains.

Cold-storage Sterilization of Sweet Oranges from South Africa.—The Senior Entomologist arranged for a trial shipment of oranges, and special precautions were taken to sterilize the fruit by low-temperature treatment before and during the voyage. No insect survived, so two larger shipments followed and were examined. Again all insects were killed, and while Valencias were adversely affected to some extent by the low temperature, Washington Navels arrived in good condition with little loss.

Lucerne Flea.—This is a serious pest of lucerne in other countries and is fairly widespread in New Zealand. From a close watch maintained on infestations, it would appear that the pest is not serious here.

Green Vegetable-bug.—This pest, which first appeared in 1944, is spreading rapidly and attacks all common vegetable crops, many flower plants, some fruit-trees, and many weeds. It is being grown in the insectary to obtain life-history data and to provide large stocks of bugs for insecticide tests.

Assistance to Therapeutant Section.—The entomologists co-operated in field trials, breeding of insects for testing, and providing basic data on life-histories in many projects such as blackberry mite on boysenberries, plum nursery-mite, and thrips on citrus.

Control of Mealy-bug on Grapes.—The effectiveness of DDT was confirmed, with indications that the recommended concentration can be considerably reduced.

Protection of Stored Potatoes Against Tuber-moth.—In preliminary work on control of the insect, residues of DDT and BHC on treated tubers after cooking were below the tolerance level prescribed by the Health Department.

European Wasp.—Population studies showed that after reaching a maximum over several years the numbers dropped back to a lower level. DDT was the most generally useful controllant, but cyanide was necessary for a quick kill.

Taxonomy of Insects.—The staff continued studies on special groups of insects, especially aphids, flies, mites, and thrips.

MYCOLOGICAL INVESTIGATIONS

Rots Caused by Phythophthora Species.—*P. cactorum* was shown to be the cause of serious collar and root-rot of apple-trees and also losses in gooseberries. Other species caused death of pine, beech, and *Erica* seedlings.

Verticillium-wilt.—This fungus is of much greater economic importance than was formerly thought, and because of its nature it seems best controlled by using resistant varieties. Four of the nine principal potato varieties showed high resistance or immunity, and five out of nine strawberries were resistant or highly resistant. Yields of susceptible varieties of potatoes were reduced by 20 to 50 per cent.

Red-core Root-rot of Strawberries.—This is a limiting factor in the economic production of strawberries in New Zealand. Nine out of thirty varieties were found resistant to the predominant strain of the fungus, but only one, Climax, shows commercial promise in this country.

Strawberry Leaf-spot.—Of twenty-two varieties tested, four were found resistant to this disease, which can cause heavy losses in individual crops.

Tomato Leaf-mould.—The Canadian varieties Freedom and L.M.R. No. 1 were markedly inferior to Improved Bay State in yield and mould-resistance.

Pea-wilt.—Of sixty new varieties tested, twenty-eight were found to be resistant. Fifty single-plant selections of Greenfeast showing maintained resistance were handed over to the Crop Research Division for further increase. All selections of W. Massey and Onward tested so far have proved susceptible.

Field Survey of Pea Diseases.—A further survey in Marlborough and Canterbury, following those of the two previous seasons, showed that the most serious diseases, in order of importance, were collar-rot, pea-wilt, and pea-mosaic.

Linen-flax and Linseed Diseases.—Further work showed that numerous races of flax-rust are present in New Zealand, and this increases the difficulty of finding resistant varieties.

Field surveys showed that volunteer flax plants play a part in carry-over and spread of rust and pasmo, while the native linum appears to be a dangerous alternative host of rust and browning.

By early sowing the variety Golden Viking appeared to resist or escape rust infection.

Dry-rot of Swedes and Turnips.—No infection was found in twenty-five samples each of one thousand seeds of swede and turnip, including all varieties grown under the Government approved seed scheme. Improvements are being sought in techniques for testing swedes and turnips for varietal resistance.

Control of Moulds in Crown-top Cork Inserts.—Growth of mould on these inserts necessitated rejections of up to 30 per cent., but a simple, inexpensive treatment that was devised overcame the trouble and is in commercial use.

Yellow-leaf of Phormium Flax.—This disease threatens the existence of the phormium industry, but its cause has been unknown. The Division, as part of a team, concentrated on the mycology and histology of the trouble, and

found that fungi, bacteria, or physiological factors did not seem primarily responsible. Evidence secured suggests that yellow-leaf may be caused by a virus.

Taxonomy of Fungi.—Work on the classification of fungi occurring in New Zealand was continued, as this is fundamental to studies of fungous diseases, and contributes to world knowledge.

BACTERIOLOGICAL INVESTIGATIONS

Crown-gall.—Only recently has this trouble become of economic importance in New Zealand. European work suggested that the disease could be controlled by lowering the pH of the soil, but glasshouse and field trials failed to confirm this result locally. Streptomycin and chemical therapeutants were tested, but only one, puratized, gave complete control without damage to plants.

Tomato-canker.—This is becoming a major disease in some areas, and field trials showed that Bordeaux and Cuprox sprays substantially reduced infection and rate of spread.

Potato-scab.—Soil pH between 4·5 and 6·5 did not affect scab incidence. The application of sulphur, which reduced pH to 3·1 to 3·6, gave the lowest amount of scab but caused severe skin-damage. Grass clippings gave the next best control, while superphosphate with or without ammonia and lime gave the highest incidence.

Stem-blight of Peas.—Experiments suggested that this disease is seed-carried.

Bacterial Disease of Iris.—Indications were that this is actually iris leaf-blight.

Effect of Inoculation on Clover Establishment.—The establishment of clovers on second-class country is difficult, but is important in increasing our production of live-stock. The use of root nodule organisms may help, and work on them is in progress. Cultures from white clover in twenty localities showed that there is a wide range in efficiency, that cultures from adjacent localities or districts are of approximately equal efficiency, and that cultures from subterranean clover, red clover, and lotus are relatively inefficient on white clover.

Cultures for Subterranean Clover.—Field tests are in progress to determine the efficacy of seed inoculation in overcoming the difficulty sometimes encountered in establishing this clover.

VIRUS INVESTIGATIONS

Virus-free Potatoes.—A search is being made for virus-free tubers of Aucklander Short-top and Dakota. One plant of the first variety was found free of potato virus X, but unfortunately it was infected with virus Y.

Chemotherapy of Viruses.—Despite many attempts throughout the world, no practical control of viruses by chemicals has yet been evolved. In work begun during the year, promising results were obtained using a substituted purine which checked or prevented systematic spread of several plant viruses when the compound was sprayed on the leaves and the virus had been introduced by mechanical inoculation. No control was obtained, however, when the virus was introduced by aphids.

Viruses in Clovers.—Two viruses were found in clovers at Palmerston North, one on subterranean and red clovers being identified as pea-mosaic, and the other, confined almost entirely to white clover, as a mixture of strains of lucerne-mosaic.

Viruses in Gladioli.—The legume virus widespread in gladioli in New Zealand was identified as pea-mosaic, while the white break or blotch flower symptom was shown to be caused by cucumber-mosaic.

Effect of Plum-mosaic on Bud Survival on Plum Stocks.—Infection in Cherry Plum stocks markedly reduced the percentage survival of apricot buds and some Japanese plum buds but had no effect on buds of English plum varieties.

THERAPEUTANT INVESTIGATIONS

Glasshouse Tests

Toxicity of Therapeutants.—In preliminary trials it was ascertained which spray or dust materials were harmful to tomatoes, raspberries, boysenberries, swedes, potatoes, peas, hops, linseed, maize seed, and onion seed.

Bio-assay Tests with Fungicides and Insecticides.—These tests indicated the relative efficacy of various materials for control of the tomato diseases, leaf-mould, foot-rot, and late-blight, damping-off in onions, citrus red-mite, hard-wax scale, apple red-mite, tomato-mite, greenfly on swedes, woolly-aphis, bean and maize weevil and tomato-eelworm. A technique was devised by which the fungicidal action of soil fumigants could be determined *in vitro* under gas-tight conditions, and the results were found to correlate with those from field tests.

Pelleting.—Pelleting of onion, carrot, lettuce, tomato, cabbage, parsnip, and sweet-corn seeds did not improve emergence as compared with untreated seeds.

Viability of Seeds After Storage.—Treated lettuce, pea, bean, turnip, beet, and celery seeds gave higher emergence than untreated seeds after three years' storage at room temperature.

Orchard Tests

Fungicides and Insecticides.—Much information was gained about the relative field performance of a number of therapeutants in the control of brown-rot of peaches, black-spot of apples, brown-spot and grease-spot of passionfruit, citrus-verrucosis, powdery-mildew of grapes, codling-moth, woolly-aphis, leaf-hopper, red-mite on apples, red-spider on grapes and strawberries, and mealy-bug on grapes. In many cases, but by no means all, some of the newer synthetics proved more efficacious than the older standard specifics.

Vegetable Field Trials

Fungicides and Insecticides.—A wide range of field trials was carried out to assess the performance of various specifics for control of tomato leaf-mould, grey-mould of lettuce, damping-off of lettuce and other vegetable seeds, late-blight of tomatoes, halo-blight of beans, cabbage-aphis, corn ear-worm on tomatoes, green vegetable-bug on beans and tomatoes, looper caterpillar on beans, and tomato-eelworm.

TIMBER TREATMENT INVESTIGATIONS

Anobium punctatum.—To provide adequate supplies for experimental work, 65,000 beetles were purchased from the public during December. In tests on blocks of *Pinus radiata* containing approximately equal amounts of heartwood and sapwood, about 85 per cent. of eggs were laid on the sapwood. To determine whether the effect of timber on egg-laying was due to extractives, twelve woods were exhaustively extracted with six solvents. Extraction with boiling water reduced egg-laying, while extraction with alcohol and ether increased it. Further work on nutrition of *Anobium* has shown that all but a few per cent. of the wood digested by the insect is alpha cellulose.

Treatment of Existing Infestations of Anobium.—In experiments now extending over five years and four flight periods, it was found that the insecticides used in practice give no better control than the carrier, power kerosene. Both DDT and BHC gave good control, but the best results were obtained with dieselene without added insecticide. This oil becomes distributed throughout the timber after surface application, and approximately a third can be recovered thirty months after treatment.

Ambeodontus tristis.—Rate of larval growth was shown to be related to the nitrogen content of the wood. In timber held under high humidity and moderate temperature the life cycle was completed in about sixteen months, while under similar conditions but with the nitrogen augmented by impregnating the wood with peptone the life cycle from egg to adult could be as short as nine months.

Preservative Treatment.—The diffusion treatment of tawa by boric acid, as developed by the Division, is being applied commercially to 4,000,000 super feet per year, at a cost less than half that of pressure treatment. Investigation of the diffusion process was extended to *Pinus radiata*, and it was found that the method was successful when the timber was green off the saw. One-inch boards needed block stacking and covering for at least three weeks after treatment, and two-inch boards eight weeks, to allow internal distribution of boric acid to take place.

Leaching Test.—This was completed. After six months' exposure to the weather, one-inch and two-inch timbers lost 30 to 60 per cent. of boric acid and the same percentage of the fluoride and arsenate of tanalith. The corresponding loss of zinc chloride was 16 to 24 per cent. Leaching was chiefly from the outer layer of wood.

Tests are now in progress to determine the permanence of preservatives in painted timber exposed to the weather.

SEISMOLOGICAL OBSERVATORY

Director: Mr. R. C. Hayes

SEISMOLOGY

During 1950 seismic activity reached its greatest intensity in the first three months. In January a disturbance originating in the region north-east of Queen Charlotte Sound accounted for a considerable number of perceptible earthquakes, many of which affected Wellington and the surrounding districts. Two shocks on 13th January were felt in Wellington with intensity M-M (Modified Mercalli Intensity Scale) 5+ and caused some minor damage. On 5th February a shock of instrumental magnitude 7, centred south-west of New Zealand, was felt in parts of Otago and Southland; while on 6th February another one centred in the Cheviot region was felt from Kaikoura to Akaroa with maximum intensity M-M 5.

The most severe earthquake during the year occurred on 1st March in the region between Taupo and Waikaremoana. It reached intensity M-M 6–7 at Te Whaiti, causing some damage in that area. On 14th March a shock of magnitude 5½–6 in the eastern Bay of Plenty gave rise to unusual sea disturbances along the Bay of Plenty coast: the maximum reported felt intensity was M-M 5–6.

In June two strong shocks in Hawke's Bay reached intensities M-M 5–6 and 5 respectively. The second of these was centred at depth 150 km. and was widely felt from Bay of Plenty to Greymouth and Christchurch.

During the remainder of the year several shocks of intensity M-M 5 occurred in various parts of the country; one of these, on 11th October, centred south of Milford Sound, reached intensity 5–6.

On 11th December a very large shock (magnitude 8–8¼) centred north-west of Kermadec Islands at depth 220 km. was felt with intensities up to M-M 4 in eastern districts of New Zealand as far south as Akaroa and about

Cook Strait. The distance of Akaroa from the epicentre is approximately 1,170 miles. This distance of perceptibility appears to be at least equal to any previously recorded.

In all, 188 shocks were reported felt in New Zealand during the year, 156 in the North Island and 46 in the South Island. Of these, 14 were felt in some part of both Islands.

All seismograph stations were in operation continuously throughout the year, except at Arapuni and Cobb. The Wood-Anderson seismograph at Arapuni was removed to Karapiro because of large and persistent artificial disturbances, and owing to hydro-electric station extension at Cobb the Wood-Anderson there had to be moved to a new site.

Tests were made at a number of points in and around Arapuni Village because of the intense artificial disturbances recorded there, but no site suitable for a permanent station was found. Tests were also made at Karapiro, Tuai, New Plymouth, and on the sites of proposed new stations at Opotiki, Rotorua, Whangarei, and Chateau Tongariro.

Early information of felt earthquake shocks is also now being received at the Observatory through the Meteorological Office, Wellington. Information is passed on to official and other organizations.

The systematic measurements of local earthquake wave periods, commenced in 1949, were completed and the results published. Progress in research work was made with the following projects: (*a*) phase analysis of local earthquakes and crustal structure; (*b*) ground vibrations; (*c*) comparison of times of reception of overseas radio time signals.

TIME SERVICE

The average error of the daily ZLW radio time signals was 0·02 second. The error very seldom exceeded 0·1 second, the maximum during the year being 0·27 second. The signals failed completely on three occasions and partially on five occasions mostly owing to causes beyond the control of the Observatory.

The Government Buildings clock was checked daily and regulated when necessary. The maximum errors observed during the year, based on the first stroke of the hour chimes, were 33 seconds fast and 27 seconds slow.

During most of the year the synchronous electric clock stopped every week owing to power cuts. It ran continuously during the first quarter, the maximum errors observed being 13 seconds fast and 5 seconds slow.

The quartz-crystal clock was reinstalled at the Observatory in March, 1950, and has since been very satisfactory, except by reason of the weekly power cuts.

A prototype automatic radio time-signal recorder was tested at the Observatory, with very satisfactory results.

GENERAL

Repair and servicing of instrumental equipment was carried out in the Observatory workshop and by the Dominion Physical Laboratory.

Several papers have been written by the staff.

SOIL BUREAU

Director: Dr. L. I. Grange

SOIL SURVEYS

General Surveys.—Work on the soil map of the South Island has chiefly been centred on drawing up a comprehensive legend of the soil types and in obtaining further information on the soils of the Dipton district in Southland and in modifying the classification of soils in the Mackenzie country, which were previously mapped for the bulletin dealing with soil erosion.

Detailed and District Surveys.—Information has been assembled on the soil types mapped in the Lake Taupo, Atiamuri, and Mangakino districts during the previous year. At Atiamuri and Mangakino on all kinds of soils there is an initial flush of clover growth, but on the water-sorted deposits of pumice in the valley bottoms the pastures soon revert to low-fertility grasses. Coarser-textured soils of some extent around Lake Taupo may behave similarly when sown down.

A total of 20,000 acres of the Gisborne flats has been surveyed. Of the alluvial soils, only 4,000 acres are well drained and highly suitable for a variety of crops.

On the flats of Central Otago fourteen soil types have been recognized, but only five of them are suitable for orchards. These five include 3,000 acres of first-class orchard land and 5,000 acres of second class.

Field-work on Southern Hawke's Bay covering 1,200 square miles is complete, and maps have been prepared of most of the area.

The iron pan on the Steward Settlement, near Oamaru, was mapped, and tests showed it to be fairly impervious. The prospects for irrigation were considered sufficiently promising to warrant a trial on four adjoining farms.

A bulletin is being prepared on the soils of Whangarei County.

A rapid soil survey was made of the islands of the Lower Cook Group—Rarotonga, Mangaia, Mauke, Atiu, Aitutaki, and Mitiaro. Soil maps were made and all the main soil types have been analysed for their plant-food content. Soils which are now being cultivated generally have a good natural fertility, except that a few types need phosphate for some crops if better yields are to be obtained.

SOIL CHEMISTRY

Clay Minerals.—The nature of the clay in the main soil types has been determined. In the normal soils the minerals depend on how far weathering has progressed.

Soil Phosphates.—Recent overseas experiments have suggested that the use of labelled phosphorus may be complicated by radiation effects. Experiments are in progress to check the effect of radiations from radioactive phosphorus on the growth of rye-grass.

Corrosion of Cement-asbestos Pipes.—Experiments to elucidate the effect of aggressive water show that the amount of carbon dioxide present and its diffusion rate through corroded to fresh surfaces are both important.

SOIL BIOTICS

Trace Element Surveys.—Maps showing the available copper content of the main soil types of North Auckland, and maps of New Zealand showing soils on which cobalt deficiency may be expected, have been supplied to the Animal Research Division of the Department of Agriculture. Studies on boron uptake by pasture plants on the Omu soil suite show that the boron content of rye-grass can be varied from 5 ppm. to 500 ppm. without change in external appearance.

Niue Island Soil-fertility Trials.—Unproductive soil from Niue Island was examined in pot trials. Results indicate that field trials with potash manures and legume crops to supply nitrogen might show the way to reclaim 8,000 acres of unproductive soil.

Soil Phosphates.—The ability of certain soil micro-organisms to use insoluble forms of phosphate has been investigated. A large number of micro-biologically produced organic acids which occur in soils and composts were found to be capable of dissolving mineral phosphates.

SOIL PHYSICS

Agricultural Soil Physics.—Examination of the physical properties of pumice soils indicates that their capacity to retain moisture is greater than for normal soils of similar texture, and that organic matter has a marked physical effect.

An investigation into the properties of some New Zealand loess deposits indicates that they show finer and less uniform particle size and lower porosity and permeability than the average American sample.

Soil Mechanics.—Sites were examined in Nelson for extensions to the public hospital and for a new fruit-storage building.

Extensive tests were made at Ngakawau, near Westport, to provide information for the design of tower foundations for the lowest section of the Stockton Ropeway.

The soil types at Nandi Airfield in Fiji were examined with a view to the development of the field to Class C international standard. About one-half of the site is situated on a heavy, highly plastic clay which is fairly uniform.

A uniform bed of clay soil 15 ft. thick underlying alluvial gravels has been examined with a view to predicting settlements of the piers of a new bridge over the Hutt River. Settlement observations on oil-tanks located above this clay nearby have shown good agreement with predictions.

Rotating vane equipment for measuring the shear strength of clay soils has been used on the Hauraki Plains.

The physical properties of soils derived from andesitic ash showers have been examined and attempts made to correlate the results with minerals identified in the clay and silt fractions.

WHEAT RESEARCH INSTITUTE

Director: Mr. E. W. Hullett

Testing Services.—Because of bad weather during the 1951 harvest, a moisture-testing station was maintained at Ashburton for a month.

The attack by wheat-bugs on some wheat lines of the 1950 harvest, and extensive sprouting in Canterbury wheat of the 1951 harvest, caused an increase in the use made by millers of the wheat- and flour-testing services. Most millers were able to avoid bug-damaged lines, but the proportion of sprouted lines in the 1951 harvest was so high that practically all Canterbury millers were obliged to accept more sprouted wheat than was desirable.

Sprouted Wheat.—A moderate proportion of sprouted wheat improves bread quality, but too much causes the bread to appear to be too moist or to have been underbaked. Because of this, the Institute issued in March, 1951, a bulletin to all bakers giving methods by which the effect of sprouting could be minimized. Advice was also given to other manufacturers using flour. The Institute showed that the " acid-dough " method, developed in England for other purposes, can be used to control sprout-damage in bread and crumpet making. Another method, which is unsuitable for food products, was developed for industrial applications.

Fermentation Investigation.—Some flours made during 1950 had insufficient capacity to provide sugar needed by yeast during breadmaking. Advantage was taken of this to carry out a study of the sugar needs of fermenting doughs. One finding of practical importance was that sugar requirements are much higher for long dough processes than for short ones. An extension of this investigation was made to elucidate questions arising from a request from bakers that the Institute's tests should be altered to secure rejection by the Wheat Committee of flours deficient in natural sugar.

Taints in Flour.—An epidemic of taints in flour was shown to have been caused by the spilling of small quantities of hormone weed-killers in the holds of two ships. Several trial shipments of flour samples were necessary to remove doubt about the cause of the taints and to verify its removal.

Extension Activities.—Further development of extension service to bakers took place. It has been increasingly apparent that the attainment of the benefits in respect to labour saving and bread quality that are possible with the growing mechanization of bread production is often impeded by organizational problems. Because of this, a study was begun of production-planning in the larger bakeries. Two officers spent a month at one of the largest bakeries and took a major part in a far-reaching and successful reorganization of production. The Institute's bakers made instructional visits to many bakeries, very often in response to requests for advice.

At the invitation of the Federation of Master Bakers and Pastrycooks, a series of articles on breadmaking was provided for publication.

REPORTS OF RESEARCH COMMITTEES OF THE COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

BUILDING RESEARCH

Research work of interest to the building and construction industry has continued. An intensive programme is being undertaken by the Dominion Laboratory and Dominion Physical Laboratory on cement and concrete, particular attention being given to the use of New Zealand pozzolanas in concrete. The Dominion Laboratory has continued its investigations of paints and other building materials. At the Dominion Physical Laboratory, investigations include efficiency of domestic fireplaces, effects of earthquakes on structures, and hydraulic testing of models of various dam structures for the Ministry of Works. The Plant Diseases Division has continued to service the building industry and to carry out research on timber-destroying insects and methods of timber preservation.

The Dominion Laboratory's work is reported under "Rocks, minerals, and Clays," p. 19, and "Building Materials," p. 24; the Dominion Physical Laboratory's work under "Hydraulics Research," p. 27; "Engineering Seismology," p. 27; "Heating Research," p. 28, and "Concrete Research," p. 28; and the Plant Diseases Division's work under "Timber Treatment Investigations," p. 55.

HOP RESEARCH

During the year the Station Director resigned and a part of the research programme has been reallocated. The Crop Research Division has undertaken the hop selection and breeding work, and the Cawthron Institute has accepted responsibility for the fertilizer trials. Quarantine of imported vegetative and seedling material remains a function of the Plant Diseases Division. The Chemical Engineering Section of the Dominion Laboratory continues its responsibility for work on drying, and the Cawthron Institute continues in charge of mycological and chemical work.

DEPARTMENTAL WORK

Imported hop varieties of high "preservative value" from Wye College, England, were graft tested to indicator plants for presence of virus, and the nine plants showing symptoms were rogued. Tests on the remainder will be continued for another year, because symptoms may not appear until the

season following infection. All hop material in quarantine, including imported seed and plants raised from such seed, is being transferred to the Plant Diseases Division for ease of observation and testing prior to clearance and despatch to the Hop Research Station.

A feature of the manurial trials in 1949–50 was the response to the December application of sulphate of ammonia. On plots so treated the hops were noticeably less prone to shattering.

Exploratory hop-drying tests in a small model kiln indicated that the rate of air circulation through the hops is of less importance than the temperature of drying. The optimal rate of air flow appeared to be about 30 ft. per minute, calculated on the empty kiln space. A drying schedule based on a constant air-temperature of 120° F. on the under-side of the hop floor was less efficient than one in which the temperature was allowed to rise from 120° F. to 140° F. during the first three hours and was then held at 140° F. for the remainder of the drying period.

CAWTHRON INSTITUTE WORK

The survey of hop soils was completed and every grower was given details of the plant-food status of his garden, together with advice on future manurial treatment.

Four of the manurial trials were continued this season, but owing to variability of hills and the presence of disease only two were fully recorded. The results were not clear-cut, but indicated that 10 cwt. standard hop fertilizer was better than 5 cwt. In one case an application of 15 cwt. gave a still higher yield, while in the other it appeared to be detrimental. In the two gardens recorded, the dry-matter content of the hops was 22·9 per cent. and 22·0 per cent., and the corresponding yields of dry cured hops from 1 bushel of green hops were 0·79 lb. and 0·88 lb.

It was shown that hops on certain soils are affected by boron deficiency. Analyses so far available suggest a desirable boron level of not less than 20 p.p.m., but further work is necessary, and trials have been laid down in nine gardens in different parts of the Nelson district. (Further details appear in the Cawthron Institute main report on p. 70.)

Surveys of hop-gardens were again made for the presence of black root-rot. In Motueka three out of sixteen gardens were fairly heavily infected, while eight were lightly infected. In Riwaka eighteen out of twenty-five showed light infection. At Upper Moutere the gardens were relatively free, with only one heavy and three light infections. In the Wai-iti - Belgrove area the twenty-two gardens examined were free of the disease, but two gardens in Waimea West were infected.

During the course of the black root-rot survey an upcurving of hop-leaves was noticed in a number of gardens, and in others a defoliation of Greenbine plants with accompanying brown discoloration of the root cortex was seen. These obscure disorders will be further investigated.

On plots laid down previously to test the value of chemicals for treating infected soils before replanting, no black root-rot symptom has yet appeared even on the control plants. Growth of plants, however, was somewhat better on plots treated with calcium cyanamide, and was much better on plots treated with chloropicrin or with D-D.

In chemical tests aimed at disinfection of hop-crowns when opened up in the spring, improved growth of shoots followed the use of borax, common salt, or Cuprox, but damage resulted from the use of copper-lime dust, Fermate dust, zinc oxide, or Bordeaux mixture.

An examination of the root systems of Californian and Greenbine hops showed strong vertical root systems penetrating to at least 4 ft. to 6 ft., with a smaller number of lateral roots mainly confined to the topsoil or organic layer. The vertical roots of the Californian were directly below the crown, whereas those of Greenbine were arranged in umbrella fashion from the outer part of the crown.

While Californian was much more heavily infected than Greenbine with black root-rot, four out of seven Greenbines showed some infection. The disease was seldom found to any marked extent in roots below a depth of 12 in., and infection usually proceeded from the crown along the root. Infection was heaviest in low-lying areas with high water table.

Analyses of hop roots showed that the concentration of nitrogen and minerals was greatest in the crown and least in the lower half of the roots.

MANUFACTURERS' RESEARCH COMMITTEE

Secretary - Executive Officer: Mr. C. P. McEvedy

Manufacturing industries have been assisted in the application of scientific research and technological developments as a means of achieving greater efficiency and increased productivity. A close relationship is maintained with the New Zealand Manufacturers' Federation, which provides liaison between the Department and manufacturers.

Research Associations.—The five industrial research associations have continued to make good progress. The keen interest of member firms ensures the early application of new developments, with consequent rapid improvements in processes and products. The success of these associations has assured the Committee that this form of scientific organization is most suitable for a group of manufacturers. Furthermore, the Committee is convinced that expenditure through research associations yields consistently valuable results and is fully justified.

During the year the New Zealand Pottery and Ceramics Research Association was expanded to include the heavy-clay-products industry. The Committee considers that other research associations should be formed, and that selected smaller industries should be encouraged to establish research fellowships.

Servicing of Industry.—Special facilities in departmental laboratories have been used to assist industry on scientific and technical problems and also in carrying out work which could not be performed elsewhere in New Zealand.

The functions of the Industrial Liaison Officers at Auckland, Christchurch, and Dunedin have been extended by conducting surveys on common technical problems in order to provide basic information for research that will be directed towards eliminating the causes of these difficulties. A Fuel Advisory Service has been operating in the South Island for the more efficient use of coal in steam-boiler plants.

The Committee has been active in many other matters of wide general interest in its efforts to assist the manufacturing industries through the resources of the Department.

MINERAL RESOURCES COMMITTEE

Attention has been given to the many problems arising in the development of the mineral resources of New Zealand. During the year the Committee was reconstituted, and in its advisory work on the exploration, development, and use of mineral resources it co-ordinates the research on minerals of the Department of Mines, the Department of Scientific and Industrial Research, the Department of Industries and Commerce, and the Otago School of Mines.

RADIO RESEARCH COMMITTEE

The Committee has continued its work on promoting and co-ordinating radio research activities in New Zealand. Within the Department these are undertaken by the Radio Section, Dominion Physical Laboratory (see page 31).

In addition, the following researches are being conducted under the Committee's ægis:—

Seagrove Radio Research Station.—This Station has now been established by the Department at Seagrove, Auckland, and is operated by the Auckland University College under grant. Its main purpose is the investigation of long-distance radio signals with a view to seeking a better understanding of the transmission and reception of such signals. It is sponsored by the Post and Telegraph Department and National Broadcasting Service, and will, it is hoped, provide data which will assist in the better design of equipment and the improvement in the operation of long-distance radio circuits. The Station is now in operation, research staff have been appointed by the college, and the research programme is being actively pursued.

Meteor Research.—Under grant to the Canterbury University College, the Senior Lecturer in Physics is undertaking investigations by radar methods of meteor showers, velocities, and turbulence. This research study has a bearing on radio propagation conditions, and information is sought leading to a better understanding of the physics of the upper atmosphere. The project seeks data in the Southern Hemisphere for correlation with similar data in the Northern Hemisphere. A field station and equipment has been established and the researches are being actively pursued.

Auroral Photography.—Auroral conditions in Antarctica affect radio propagation in the New Zealand area. On the recommendation of the Radio Research Committee, the Carter Observatory has accepted responsibility for the collection of data by means of auroral photography which will assist in the explanation of certain radio phenomena. To enable the Observatory to undertake this work it is assisted by grant from the Department.

The camera base line in Southland has been established and the collection and analysis of data is in progress.

TOBACCO RESEARCH

Station Director: Mr. R. Thomson

The weather was abnormally dry in winter, spring, and early summer, but rain at the end of December, followed by frequent and heavy rain from mid-January onwards, relieved an unpromising outlook for the crop. Temperatures were fairly equable throughout the growing season.

During the year the Director visited the United States and Canada, and gained valuable information on research progress in the two countries.

Research Programme.—The work was continued as a joint project of the Station and the Cawthron Institute.

The Institute undertook disease surveys, investigation of the nature, spread, and control of various diseases, chemical studies on the intake of plant nutrients and their effect on the chemical composition of the cured leaf, and chemical analysis of leaf from field trials and curing experiments.

Station work included seedling-bed investigations, fertilizer trials and cultural experiments, variety trials and seed-production work, curing experiments, plant-breeding, and control of diseases in the field.

Soil Sterilization.—The amount of soil steam-sterilized for growers reached a new record of 672 yards.

Seedling-bed Investigations.—Steam again proved the best means of controlling weeds; methyl bromide applied in the autumn gave promising results,

but as a spring application was less effective. Neither chloropicrin nor calcium cyanamide was very satisfactory. Seed distribution by use of a watering-can gave a uniform distribution and a more even and rapid germination. Better plants resulted from thorough watering at intervals of several days than from light daily waterings.

Fertilizer Experiments.—A rate of 1,400 lb. fertilizer per acre produced the best yield and quality under Station conditions, and no benefit resulted from a further increase of 200 lb. With varying levels of nitrogen, phosphate, and potash in combination, 4 per cent. nitrogen again outyielded 3 per cent., with no reduction in quality of leaf. Low phosphate resulted in delayed early growth followed by later maturity. Leaf quality suffered as the result of a lack of potash, particularly with the higher level of nitrogen. The benefit from including 2 per cent. magnesium in the fertilizer mixture was apparent in the growth of the crop. Five pounds of borax per acre did not affect the yield, but resulted in brighter leaf of improved texture.

In a cover-crop experiment the results obtained confirmed those of the previous season.

Chemical substances were applied to topped tobacco-plants in an endeavour to reduce lateral growths, and striking results were obtained with both maleic hydrazide and paraffin oil.

Variety Trials.—Of the varieties under test, Harrison's Special 215 gave the highest yield combined with good quality. Of three Vesta lines from Virginia, Vesta 46 yielded well and was of satisfactory quality. Delcrest, a Canadian variety resistant to black root-rot, did not yield well. The variety Hicks produced a very narrow and therefore unacceptable leaf, as also did two varieties from South Africa. These two proved very susceptible to black root-rot.

Plant-breeding and Seed Production.—A number of lines combining good leaf type with resistance to black root-rot were raised, but further selection is necessary because some of the lines still retained a trace of the cigar aroma of the resistant parent. Lines with good mosaic resistance drawn from the Ambalema variety were developed, but still left much to be desired in leaf type. Work is now in progress using the resistance of *Nicotiana glutinosa*. The attempt to breed a variety resistant to verticillium-wilt continued, but will not be easy since no completely resistant variety has so far been found.

Seed production was extended beyond the Station to nine selected areas this season.

Disase Investigations.—Inspection of seedling beds showed very little angular leaf-spot or black rot-rot, while mosaic was seen in only a few instances and was not severe.

A survey made at a later date indicated that mosaic was less than in former years, but that other virus diseases were more prominent. Spotted-wilt had increased in Riwaka and to a less extent in the other two districts, while a few cases of ring-spot were seen in Riwaka and Dovedale. Laboratory work suggested a wide distribution of black root-rot in Motueka and Riwaka. Angular leaf-spot was seen in a number of gardens, and in five cases the infection was rather severe.

Variation in rate of fertilizer application to either seedling bed or field crop, or the use of different cover crops, had no influence on field incidence of mosaic. Likewise, the disking-in of stalks from the previous crop did not increase the amount of mosaic. The field crop from bed-sown plants again showed far less mosaic than that from pricked-out plants.

In seedling-bed tests, chloropicrin, calcium cyanamide, and D-D were effective controllants of black root-rot. Susceptibility tests of various plants

showed that rye was not attacked by the fungus, vetch and red and white clovers developed only slight infection, while gorse was more heavily infected. Of various chemical treatments tried on infected soil, sulphur at 12 cwt. per acre effectively controlled black root-rot.

Chemical tests on soils heavily and uniformly infected with verticillium wilt gave the following percentages of infected plants as compared with a 60 per cent. infection in the controls: calcium cyanamide, 12; T.M.T.D., D-D, and Ferbam, 22–28; borax and bleaching-powder, 50. It is a matter of concern to the industry that verticillium-wilt appears to be spreading; three new cases were found this season.

Insect Pests.—Good control of tobacco leaf-miner was obtained last season by a 2 per cent. D.D.T. dust used at 20 lb. per acre. Although the insect was present this season, no serious damage was done.

Cutworm larvæ were prevalent in seedling beds this season, and vegetable weevil was found in appreciable numbers on seedlings. For the first time since the establishment of the Tobacco Research Station, springtails damaged tobacco seedlings, but were effectively controlled by derris dust and nicotine sulphate.

Chemical Investigations.—In studies on the effect of fertilizers on chemical composition of tobacco, only minor variations in plant-food constituents were found in leaf samples from plots with varying ratios of nitrogen, phosphate, and potash. Magnesium content was increased by magnesium applications, and potash content by higher rates of potassic fertilizers. Leaf composition was little affected, whether the fertilizer contained 3 or 4 per cent. nitrogen. Sugar content was little affected by any treatment and averaged about 25 per cent.

The chemical composition of green-manure crops, in the above-ground portion of rye-grass, rye-corn, lupins, and oats with vetches, were: percentages of phosphoric acid, 0·77, 0·72, 0·88, and 0·89 respectively; percentages of nitrogen, 1·34, 1·17, 3·10, and 2·01 respectively. The nitrogen content of the roots of these four crops, in order, was 1·4, 0·97, 3·68, and 1·4 per cent.

Plots at the Station have received borax at the rates of 0, 5, and 10 lb. per acre for each of three successive seasons, but analysis showed no accumulation of borax in the soil. Leaf samples, on the other hand, had boron contents of 18, 46, and 67 p.p.m. (parts per million). From other evidence it would appear that a normal value for boron in tobacco-leaf would be at least 20 p.p.m.

A laboratory investigation into changes occurring in tobacco-leaves during the colouring stage of curing showed that the rate of respiration was approximately 5 mg. carbon dioxide per gram of dry matter and was proportional to the protein-nitrogen content of the leaf. A great reduction in starch content occurred with a concomitant increase in reducing sugars and sucrose. The lower the hydrolysis of starch, the greater was the hydrolysis of protein. Soluble sugars were highest where hydrolysis of protein was low, and in some cases the loss of starch was sufficient to account for the entire loss of dry matter and the amount of sugars produced.

Kilns and Curing.—Delays in preparation of detailed working-plans of the large experimental kiln prevented its erection for the 1951 season, but work was continued in the three experimental curing-cabinets. The effect of varying temperatures and humidities on the colouring of the leaf and on the quality of the cured product was examined, and one trial was made to determine the effect of variations in the final temperature on drying of the midrib.

Area of Tobacco, 1950–51.—After a decline last year, the acreage this year showed a very slight increase. The Motueka-Riwaka district accounted for rather more than half the total area of 3,904 acres.

REPORTS OF INCORPORATED RESEARCH ASSOCIATIONS

THE DAIRY RESEARCH INSTITUTE (N.Z.)

Director: Professor W. Riddet

The financial year of the Institute ends on the 31st July next, when a separate report will be issued by the Institute. The following summary, not included in the Department's 1950 annual report, is on investigations for the year ending 31st July, 1950.

Butter.—Experimental trials have been made of the effect of addition of 0·005 per cent. of the antioxidant substance nordihydroguaiaretic acid (NDGA) to butter on the rate of development of storage flavour during holding at low temperatures. The addition reduced the amount of oxidation occurring in the fat during eight months' storage as revealed by oxidation tests, but the retardation of oxidation did not result in an improvement in the grade of the butters. The storage flavour was still noticeable in the treated butters, and, in addition, the antioxidant imparted a "chemical" or "metallic" flavour to the butter. A study has been made also of the seasonal variations in proportion of unsaturated fatty acids in the butterfat, since the proportion of these acids present also probably influences the development of storage flavour.

Caustic soda was found to be a satisfactory substitute for the usual sodium bicarbonate neutralizer employed for acidity-reduction in cream before pasteurization. It must be added carefully and with simultaneous strong mechanical agitation.

Comparisons have been made of use of a stainless-steel rollerless churn and the normal roller-type churn for buttermaking under New Zealand conditions. Butter made in the metal churn was of good quality, but the colour was rather deeper and the body was slightly more greasy than for butter made in the normal churn.

Dried Milk.—Investigations have been made of a number of alternatives to the lined hessian sack for use in milk-powder packaging. Assistance and advice have been given to manufacturers of dried milk and casein.

Cheese.—In cheese-starter investigations twenty strains of streptococci from overseas were examined and their relationship to the stock strains at present in use was determined. None of the new strains has so far proved suitable for use in New Zealand. It has not been possible, therefore, to add to the seven unrelated single strains in general use at present in cheese factories.

The influence of potassium and manganese salts on the development of flavour in cheese has been investigated. Potassium salts have a slight influence on flavour, but in general the results obtained were disappointing in that they they did not give any promise of a really satisfactory explanation of the mechanism of flavour development.

In co-operation with the Dairy Division of the Department of Agriculture, trials were made of the manufacture of cheese with 52 per cent. fat in the dry matter. No difficulties in manufacture were experienced and there seems little doubt that technically the manufacture of fat-adjusted cheese is quite satisfactory.

Four tons of blue-veined cheese were made and sold, and such was the public demand that it is thought 50 tons to 100 tons could be disposed of. The system of manufacture is commercially satisfactory, although there are day-to-day variations in the product that need investigation.

Animal Physiology.—Work on dairy-cow nutrition has been continued. Investigations have also been made on the relationship between butterfat

percentages and solids-not-fat percentages, the calculation of average fat percentage and total butterfat yield from herd-test records, and the average size and variation in size of body organs.

Engineering.—A survey of engineering services in dairy factories has been carried out. A preliminary investigation has been made into the use of the vacreator for concentration of buttermilk and into the recovery of waste heat in the vacreator.

THE N.Z. FERTILIZER MANUFACTURERS' RESEARCH ASSOCIATION (INC.)

Director: Dr. M. M. Burns

The major work during the year was associated with establishing the station at Papatoetoe, and the Association now has a fully integrated unit to undertake research.

Research.—Projects were mainly confined to pot trials with radioactive phosphorus, and to field trials with mixtures of weed-control hormones with fertilizers.

In the trial to study the uptake of phosphorus by rye-grass from added phosphoric acid and soil sources, the results showed that in the early stages of growth the plants obtained 80 per cent of their phosphate requirements from the fertilizer and 20 per cent from soil sources. In the later stages of growth the uptake from soil sources increased, but at the final harvest after six months more than half of the absorbed phosphate was still being supplied by the fertilizer.

In a series of trials with mixtures of the dry sodium salt of 2·4D and fertilizers it was shown that superphosphate and related products are suitable carriers for this material and that control of susceptible pasture weeds can be achieved during normal spring top-dressing operations by the application of mixtures containing the equivalent of 1 lb per acre of this hormone.

Studies are being made on the preparation of hormone-fertilizer mixtures, physical characteristics of phosphate fertilizers, and on the comparison of various phosphate fertilizers.

NEW ZEALAND LEATHER AND SHOE RESEARCH ASSOCIATION (INC.)

Director: Mr. F. W. Woodroffe

Substantial progress has been made by the Association during the second year of its existence as an incorporated body. The membership had increased during the year from forty to seventy-four.

Leather-manufacture.—The investigation on the yield of sole-leather have been completed and results have been published that will have application to the economic production of sole-leather.

Oil tannage has received some consideration and methods of scientific control of this type of tannage have been evolved. The unsuitable oils produced in New Zealand have been modified in order to make them satisfactory, and the engineering side has been fundamentally changed, resulting in a saving of time. Further work is in hand which promises to make oils hitherto of no use in oil dressing acceptable for this type of dressing. Work is now proceeding on chrome tanning, fast-to-light synthetic tannins, enzyme unhairing, and the possibilities of using the bark of New Zealand grown *Pinus radiata* as a source of vegetable tanning material.

Conferences of works' technicians have been held in Wellington.

Hides.—Brining trials have been completed which show promise of improved results compared with stack salting.

Pelts.—Investigations have been carried out on depilatory paints with a view to modifying the caustic alkali present that causes excessive swelling and is a danger to the pelt structure. Work is in hand with modified paints and the use of other depilatories than sodium sulphide. Attempts are being made to relate microscopic observations of the pelt structure with the leather produced from that pelt. Samples are received continuously for examination and microscopic report, and this service is of great value to the fellmongers.

Footwear-manufacture.—Many of the 123 problems concerned with footwear were found to be due to customer abuse. In an endeavour to rectify this, a series of articles on the use of footwear was published.

Since his arrival in New Zealand the Director has made a special effort to meet all the shoe-manufacturers in order to obtain a clear picture of the needs of this very important consumer of New Zealand leathers, and on this information to develop a research policy.

THE NEW ZEALAND POTTERY AND CERAMICS RESEARCH ASSOCIATION (INC.)

Director: Mr. W. Vose

Raw Materials.—Additional work was performed upon kaolin-bearing deposits—*i.e.*, the Mount Somers decomposed rhyolite and the Matauri Bay clay. The latter, like most of the North Auckland clays, is not kaolinitic, but halloysitic. In general, the supply of New Zealand kaolins (china clay) are satisfactory, and such improvements as are possible have been revealed. The New Zealand potential supplies of felspar are still confined to the Baton Valley pegmatite—the main supply at present—and the Baton Saddle decomposed granite. These two deposits are not too satisfactory, but flotation and magnetic separation have shown promise of success in reducing the Fe_2O_3 contact. The search for more suitable deposits continues. Work upon plaster-of-paris has led to the very successful introduction of alpha-gypsum into members' factories. Attention has been paid to New Zealand sources of ball-clays, and it is believed that New Zealand has clays similar to good-quality English clays.

Processes.—An investigation into the drying of clay bodies has shown that the dry strength is not the fixed determinate property as has always been understood. Investigations upon the size separation of ceramic materials using the "Driessen Cyclone" have been made. The phenomenon of "spit-out" in firing the decoration on to earthenware has been examined and recommendations made. Investigations into the reduction in the firing temperatures of stoneware were successful.

Investigational Methods and Apparatus.—An interferometer apparatus has been applied to the measurement of thermal expansion of small test pieces. This technique obviates some serious limitations in the orthodox method and has demonstrated a new phenomenon of possibly great practical importance in the cracking of ware during firing. The distortion of ware during firing is dependent upon the plastic properties of ceramic bodies at high temperatures, and a precise method of measuring these properties has been developed. A survey of colour measurement methods of use in ceramics was made and a simple but sensitive piece of apparatus adopted. With the collaboration of the Soil Survey, investigations have been made upon the application of the Noreleco X-ray spectrometer to the quantitative phase analysis of ceramic raw and fired materials. Fundamental investigations upon compositions of the clay-felspar-quartz type have been furthered.

Heavy Clay Products Research.—The proposed extension of the Research Association to include the manufacturers of bricks, field tiles, sewer pipes, refractories, roofing-tiles, and similar products, awaits Government approval.

Reports.—Individual reports have been issued to manufacturers upon their problems, nine interim reports have been prepared and circulated, and four final reports have been given full distribution.

NEW ZEALAND WOOLLEN MILLS' RESEARCH ASSOCIATION (INC.)

Acting-Director: Dr. L. F. Story

Worsted Oil Trial.—Comparative tests have been made with six oils, three of which are in current use in New Zealand mills. The others were a standard British combing-oil, a New Zealand neatsfoot-oil low in free fatty acid, and olive-oil. In general, differences between the batches treated with these oils were small, except in drawing, where some of the oils permitted much more fly than others, and in scouring, where the oils based on mineral oil were less readily removed than the others by the soap and soda scour used.

Three subsidiary experiments were carried out: (1) Small pieces of top containing the various oils were distributed to the worsted mills to be dyed and backwashed. Slight variations in shade due to the different oils were noted. Generally the oil content of the dyed and backwashed samples was not very different from its initial value, but in some cases there was a large decrease due to an efficient scouring in the backwash instead of rinsing only. (2) Neatsfoot- and olive-oiled tops were stored for a period before drawing and were then drawn by two methods, one with one stage less than the other. There was no noticeable difference between the results of the two processes. Less fly was noticed with the stored tops than previously. (3) In scouring, Lissapol N was found to remove the mineral oils satisfactorily. It was customary to mill the pieces for a short time, but this was found to be not really necessary, and, if anything, pieces that had not been milled had a slightly better appearance than milled pieces.

Syton W20 in Worsted Processing.—A further trial is being carried out to test the effect of three different amounts of Syton as compared with no Syton. The strength of the yarns was considerably increased by the Syton and a 10 per cent. reduction in spinning and doubling twists could be made, with consequent increased production.

Fluorescent Bleaching Agents.—Two more of these compounds have been tested and reported on. One of them was very easily applied and economical. It was fast to washing, but, as usual, not very fast to light.

Effect of Copper on Wool Dyeing.—Copper sulphate is being increasingly used in sheep-dips as a bactericide and fungicide.

Many dyes, particularly those dyed by the afterchrome method, are affected by copper, which forms a copper complex with the dye in preference to the desired chromium complex. As dye-manufacturers' ratings of the effect of copper on their products are determined by dyeing in the presence of metallic copper, it became of interest to determine the effect of copper actually on the wool on dyes, and also on peroxide bleaching and the formation of stains, and it was found that 0·01 per cent. was the maximum that could be tolerated. Even this small amount had a noticeable effect on weak dyeings of sensitive dyes.

So far no reliable data has been obtained on how much copper to expect on wool that has been dipped in a copper-containing liquor.

The effect of minute amounts of copper when evenly distributed over a batch of wool has been strikingly demonstrated by the accidental contamination of carbonized wool with copper at a mill. A dyeing with 0·5 per cent. of Solochrome Brown M was markedly off shade though the amount of copper present was only 0·007 per cent.

Services.—As in previous years, a wide range of general testing and analytical work has been carried out.

RESEARCH INSTITUTE OF LAUNDERERS, DRY-CLEANERS' AND DYERS OF NEW ZEALAND (INC.)

Research Officer: Mr. P. Carlyon Coates

Activities of the Institute have been considerably extended during the past year.

The work of the laboratory has been mainly concerned with the investigation of textile damage. The methods and technique used in these investigations are based upon those learnt by the Research Officer in the laboratories of overseas research organizations during visits to other countries. Other investigations carried out included comparison of the relative serviceability of different types of sheets and the examination of certain kinds of synthetic rubber gloves for use in dry-cleaning plants.

A highly successful convention and exhibition was held in Christchurch during the Canterbury Centennial celebrations. A series of technical lectures was delivered and a display of machinery and equipment staged. The laundry and dry-cleaning industries were represented by visitors from all parts of New Zealand and from Australia.

Regular weekly distributions have been made of bulletins and other technical information received from overseas research organizations. These have been supplemented by bulletins issued by the Institute.

CAWTHRON INSTITUTE

Director: Sir Theodore Rigg

Aided by grants from the Department of Scientific and Industrial Research, work has been carried out on a wide range of problems of the tobacco, hop, fruit, and tomato industries of Nelson. Other research work has included entomological, soil, and plant nutrition studies. Tobacco, hop, and entomological research is carried out in collaboration with officers of the Department of Scientific and Industrial Research and is reported conjointly under the headings of Tobacco Research, Hop Research, and Entomological Research Station in other sections of the annual report of the Department. The following account reviews investigations not reported elsewhere.

SOIL INVESTIGATIONS

Soil-fertility Survey of Hop-gardens in the Nelson District.—Chemical data have shown a very low supply of potash in the majority of gardens. Some gardens required lime treatment, while others were neutral in reaction, suggesting the possibility of minor-element deficiency as a result of excessive lime applications.

Soil Map of the South Island.—The Institute has co-operated with the Soil Bureau (D.S.I.R.) in the preparation of a soil map on a scale of 4 miles to 1 in. covering the Nelson Provincial District. During the past winter work was carried out in the Waimea, Takaka, and Collingwood Counties. All the chemical work on soil samples required for the classification of soils in the Nelson district is being carried out in the laboratory of the Institute.

Utilization of "Moutere Gravel" Land.—In co-operation with the Soil Bureau and the Department of Agriculture, surveys have been conducted over some 300,000 acres of "Moutere gravel" land in respect to vegetative cover, land slope, soil classification, and chemical characteristics of the soils. Four papers on different aspects of the surveys were prepared for the Royal Society Science Conference.

Soil Maps of the Appleby Research Orchard.—At the request of the Director of Fruit Research, D.S.I.R., soil maps of three blocks at the orchard were made in order to facilitate the use of the land for experimental purposes.

Chemical Studies of Soils.—In addition to a great deal of routine chemical analyses required for soil classification and advisory purposes in the Nelson district, special study has been made of the molybdenum content of Nelson soils. One or two low figures for this element have been found, but further work is required to determine the value of the molybdenum estimation in indicating an actual deficiency of the element in different crops.

Other chemical studies have been concerned with the effect of different parent rock material on the base status of alluvial soils in the Waimea County. Owing to the great range of different rocks to which rivers have access, the mineral status of the alluvial soils shows great variation in both lime and magnesia.

PLANT NUTRITION

Studies of the role of trace elements in Nelson crops have been continued. The most important feature of the work has been the identification of a boron deficiency in hops, and the establishment of experimental plots to study the intake and distribution of boron. Symptoms of the deficiency are a delayed and irregular growth of shoots after the initial pruning, with frequent distortion of leaves on young shoots. The Californian variety was more severely affected than the Greenbine. Surveys have shown that characteristic symptoms of boron deficiency were present in many hop-gardens last season, particularly in those located on granite or " Moutere gravel " derived soils. The field experiments have shown that the symptoms are remedied by dressings of ½ oz. borax per hill. Analyses of hop-leaves and hop cones show that the dressings are taken up by the plants, resulting in a greatly increased boron content in the leaves and a lesser increase in the cones. Thus the boron contents of untreated and treated hop-plants were for leaves 31 p.p.m. and 179 p.p.m. and for cones 22 p.p.m. and 43 p.p.m. respectively on the dry matter. Leaves from the bottom, middle, and top sections of hop-bines showed only slight variations in boron content. Leaves from fruiting laterals, however, were somewhat lower in boron. Preliminary data for the crown and roots of hops indicate that there is no great difference in the boron content of corresponding parts of Greenbine and Californian varieties. In the roots of these varieties grown at the Hop Research Station the boron content was approximately 10 p.p.m. on the dry matter; the crown of the plants was slightly higher in boron content.

Zinc Status of Hop-plants.—Estimations of zinc were made on some twenty samples of both leaf and cones collected in the course of the boron survey of hops. In the leaves the range of zinc contents was from 28 to 48 p.p.m., with the majority of the figures falling about 30 p.p.m. In the cones the corresponding levels were 46 to 62 p.p.m. It is interesting to note that, in contradistinction to the boron status of leaves and cones, the zinc content of hop cones is much higher than that of the leaves. Leaves of the top section of the bines, likewise, were richer in zinc than those from the middle or bottom sections.

Mineral and Nitrogen Status of Hops.—Six samples of hop-cones were analysed for minerals and nitrogen. The nitrogen and phosphoric acid contents were at the lower limits of values reported for overseas hops. Potash figures in the six samples gave an average about the middle of the range reported for overseas hops. Analyses of roots from the Hop Research Station showed that the Californian variety was appreciably higher in potash and phosphoric acid but slightly poorer in nitrogen than the Greenbine variety.

Minor Element Status of Celery and Broccoli.—In certain experiments on the growth of celery and broccoli at the Institute, samples of leaves and stalks of celery and leaves and curd of broccoli were analysed for minor-element contents. In the case of celery the following contents in p.p.m. on the dry basis were found for leaves and stalks: boron, 49 and 55; zinc, 68 and 38; manganese, 44 and 21; copper, 13 and 6; molybdenum, 2·6 and 0·5 respectively.

In the case of broccoli the corresponding figures for leaves and curd were: boron, 39 and 32; zinc, 62 and 101; manganese, 41 and 27; copper 4·5 and 15; molybdenum, 1·8 and 0·6 p.p.m. respectively. Except for the high content of zinc and copper in the curd and the low copper content in the leaves of broccoli, the amounts of the minor elements were of the same order in the two crops.

FRUIT RESEARCH

During the past year the more important investigations have included detailed studies of boron deficiency in raspberries, the continuation of zinc and copper trials for apple-trees at Tasman, mineral and nitrogen intake of apple-trees, and the identification of diseases in apples and small fruits.

Boron Deficiency of Raspberries.—Very beneficial results were seen this season wherever borax had been used either as a soil dressing or in sprays. Distorted leaves and poor growth of fruiting laterals were general on untreated bushes, whereas treated bushes were normal and carried good crops. It was noted that there was a distinct carry-over of benefit from a borax spray applied in a previous season.

Chemical analyses of leaves from treated raspberries on the experimental plots at Rakau and Motupiko showed relatively great increases in boron content.

In a garden at Orinoco where unsatisfactory growth of raspberries was reported in the previous season, borax applications given in two dressings in early spring and in December gave substantial responses. Analyses of leaves showed that the uptake of boron was in keeping with the rates of application.

While the recommended dressing of ½ oz. borax per bush has given very good results on established gardens, a note of warning must be given concerning its use for young plants: in one garden edge-burning of leaves occurred in newly set canes treated with ½ oz. borax per hill. Chemical analyses showed that the affected leaves contained 293 p.p.m. boron, compared with 52 p.p.m. boron on the dry matter for leaves from non-boron-treated sets.

Zinc Trials on Apples at Tasman.—Observations made during the past season have not shown any visual benefit from dormant sprays of zinc sulphate on any of the experimental plots of Gravenstein or Sturmer apples in the Tasman district. As these trials have been continued for three years without any definite improvement in tree growth, it seems safe to conclude that zinc deficiency is not a factor of any great significance in apple-orchards on the Moutere Hills type of soil. Analyses of apple-leaves collected from different orchards in the Nelson district have not shown abnormally low figures for zinc. Analyses of new buds collected from trees sprayed with zinc sulphate show that the sprays were effective in increasing the zinc content of the trees.

In confirmation of results reported last year, cherries in an orchard at Mariri did not show any beneficial effect this season as a result of using dormant sprays of zinc sulphate.

Copper Trials on Apples at Mahana.—A replicated trial with copper sprays did not show any benefit to apple-trees that had not had copper sprays for a number of years.

Mineral and Nitrogen Status of Apple-leaves from Fertilizer Trials at Appleby Research Orchard.—The analyses of a further set of leaf samples from experimental plots of Sturmer, Delicious, Jonathan, and Cox's Orange apple-trees showed the same trends in mineral and nitrogen content as noted in previous samplings. Thus absence of nitrogen, phosphorus, or potassium from the fertilizer applications was reflected in a relatively low content of the particular element in the leaves. Nitrogen when used alone or with phosphorus and potassium caused a decrease in the phosphorus and potassium contents but an increase in the calcium, magnesium, and nitrogen contents of the leaves. Potassium, in the presence of nitrogen and phosphorus, increased the potassium and nitrogen contents but decreased calcium and magnesium contents.

Fruit Diseases.—At the request of fruit and tomato growers, plant specimens have been examined for diseases and recommendations have been given for control measures. Further work has been done on the distribution of apple collar-rot and the susceptibility of different varieties of fruit to the disease.

Other work has included tests for a suspected virus infection of Cape gooseberries and susceptibility tests of three varieties of tomatoes for anthracnose.

TOMATO INVESTIGATIONS

Tests with Steam and Soil Disinfectants.—Steam, chloropicrin, D-D, a mixture of chloropicrin and D-D, and a proprietary soil-disinfectant known as Sterizal were tested under glasshouse conditions. Chloropicrin used for the fifth season in succession on the same plots proved as effective as steam for both yield and quality of tomatoes. Both D-D and a mixture of chloropicrin and D-D gave very satisfactory results, and the tomatoes were practically free from undesirable flavours noted in a previous season with D-D treatment of the soil. Sterizal, on the other hand, was not nearly so effective as the other chemicals in maintaining high yield and in controlling soil diseases.

Typical yields from plots with the different treatments were as follows: unsterilized, 4·1 lb.; steam, 9·6 lb.; chloropicrin, 10·0 lb.; chloropicrin and D-D, 9·3 lb.; D-D, 9·5 lb.; and Sterizal, 6·5 lb. per plant.

Value of Compost and Cocoa-beans Husks for Glasshouse Soil.—On steamed soil with a standard fertilizer, compost gave the highest yield, 10·4 lb., compared with 9·6 lb. per plant for the corresponding plot without compost. This season, fruit on the compost plot was of high quality. Cocoa-bean husks, used with a standard fertilizer on unsterilized soil, again gave a marked improvement in both growth of plants and yield of tomatoes when compared with the corresponding unsterilized plot receiving standard fertilizer only. Yields for the two treatments were 5·7 lb. and 4·1 lb. per plant respectively. Quality of tomatoes was very good in both cases.

Effect of Heavy Applications of Potash on Quality of Tomatoes.—Further confirmation was obtained during the past season concerning the value of large dressings of potash in producing high quality of tomatoes. Improvement in quality, however, was accompanied by a reduction in yield.

"Cloud" Investigations.—Further information has been obtained concerning factors that affect the incidence of "cloud," a physiological disorder of glasshouse tomatoes. The more important results from the work to date are as follows: (*a*) heavy watering of tomato-plants, the use of glucose or fresh organic manures in the treatment of the soil, increase the amount of "cloud"; (*b*) restricted watering of the plants, the use of heavy applications of nitrogen,

potash, potash and nitrogen, and calcium chloride, reduce the incidence of "cloud"; (*c*) no mineral deficiency has been identified in plants showing high incidence of "cloud"; and (*d*) severe lateralling of the plants and no lateralling at all effect an increase in the amount of "cloud" compared with normal lateralling.

Chemical analyses of "cloud" fruits show that they have lower dry-matter and carbohydrate contents than those of healthy fruits.

It is considered that any glasshouse treatment which greatly increases root activity and vigorous growth of the plants favours the occurrence of "cloud" in tomatoes.

UNIVERSITY COLLEGES

Grants were made by the Department to Canterbury and Massey Agricultural Colleges and to Canterbury University College.

CANTERBURY AGRICULTURAL COLLEGE

ANIMAL HUSBANDRY

Professor I. E. Coop

Sheep.—The third Corriedale progeny test, commenced in 1949, was completed in October, 1950, and a fourth test begun in 1950 will be completed at the end of 1951. The results of the third progeny test were less decisive than in the previous tests, one ram being outstanding for breed type, four for carcass quality, and none for wool. An over-all study shows that four of the eleven rams used were sufficiently above the average to warrant consideration as merit sires. During the 1950 breeding season an intensive study of the breeding behaviour of the ewes was carried out. Gestation periods, œstrus cycles, and percentages conceiving at first, second, and third services were measured. Two-tooths which failed to conceive were slaughtered for clinical examination.

Progeny testing in two stud flocks has continued. One of these is in its eighth year and has yielded a great deal of data on several aspects of variation in wool production. Lifetime fleece production records are now available from this flock. Variations in fleece weight due to season can be as high as 1½ lb.; dry ewes exceed by 1 lb. single-bearing ewes, which in turn exceed twin-bearing ewes by ½ lb. The incidence of breaks and of cotting has also been studied.

Pastures.—The chemical composition of a number of pasture samples collected from untop-dressed hill country of the South Island, and also of individual species from one locality in the high tussock land, has been determined. Considerable variation exists both between localities and between species. Samples of spring growth are generally of satisfactory composition, but late summer, autumn, and winter feed appears in many cases to be deficient in protein and minerals.

FARM MACHINERY RESEARCH

Mr. A. W. Riddolls

Small-seeds Harvesting.—Experimental work with a floating cutter-bar for a header harvester, designed to permit direct heading of short white clover, has been held up by unusually wet weather in Canterbury during the harvest period. A design has been prepared, and parts and material assembled, for construction of an experimental threshing-machine for investigating threshing damage to small seeds. This will permit carrying out of investigations independently of weather conditions.

Mechanical Ditch-cleaning.—The experimental tractor-mounted ditch-cleaning machine has been thoroughly tested, with satisfactory results. The design has been modified as a result of these tests, and the improved model is now undergoing further trials.

PASTURES

Mr. J. W. Calder and Mr. C. E. Iversen

Subterranean Clover Grazing Trial at Ashley Dene.—The season has been most favourable for subterranean-clover development and growth. The production from the experimental area reached as high as 3,799 lb. of dry matter per acre, the best yielding areas being those in which subterranean clover contributed a high proportion of the herbage. Areas on which there was a strong establishment of rye-grass or cocksfoot had little clover. It appears that dense rye-grass and dense cocksfoot are incompatible with subterranean clover and that where these grasses are sown in a mixture with subterranean clover on light land the quantity of grass should be reduced considerably below the customary sowings. On the other hand, *Phalaris tuberosea* and subterranean clover grow well together, and this mixture produced the highest total yield of dry matter.

MICROBIOLOGY

Dr. I. D. Blair

Plant Disease Survey.—New records include the fungus *Septoria myopori* Cke and Massee from *Myoporum luteum*, producing a leaf-spot disease. Work with *Phialea temulenta* has been confined to field experiments aimed to secure disease-free crops by sowing clean seed in fields isolated from other grass crops and under conditions where all other grass hosts are topped by mowing before flowering-time. North Island wheat examined for mildew revealed the occurrence of Race 4 of *Erysiphe graminis*, which with Race 3 had previously been found dominant in the South Island wheat area.

Seed Disinfection.—With garden peas (Massey and Onward) the inferior germination after organic mercury dust treatment as compared with the notable improvement following use of tetra-chloro-parabenzoquinone and TMTD preparations has been correlated with the low content of toxic ingredient in the organic mercury dusts.

Soil Microbiology.—The saprophytic phases of *Cercosporella herpotrichordes* are being studied. It has been proved that the fungus persists in straw for more than two years, and that the presence of organic forms of nitrogen is an important contributory factor. Among instances of legume failure, a bacteriophage principle has been demonstrated in lucerne tissue, and another lucerne field has been notably improved by applying 1 lb. sodium molybdate per acre. *Trichoderma viride* has been used experimentally in boron and bio-assay, but strain variation of the fungus has limited practical application of the method for regular soil-testing.

WOOL RESEARCH

Mr. A. E. Henderson

Wool Survey.—The last of the data collected over the past ten years was transferred to punched cards and results tabulated. At the same time data previously dealt with have been summarized. It is expected that the major project can be completed and results prepared for publication within the coming year. In the meantime survey operations are being maintained in one flock to provide continuity of observation for a further year.

Progeny Testing.—Work was continued within a Romney and a Merino stud. A review of progress over a number of years indicates that the practice is difficult to apply under ordinary conditions. A full summary of existing data will be made before further work in this field is contemplated.

LIME RESEARCH

The rates of solution of a wide selection of South Island limestones in relation to certain of their physical properties have been published. The results emphasize the need for top-dressing experiments to test limestones of various degrees of fineness on different soil types. These results will help in deciding the most effective and economic method of top-dressing pastures with limestone. Sampling technique and soil analyses have been standardized by carrying out a pilot trial before laying down the complete trial this autumn. In tests on fifty farm and garden crops a wide range of acidity in the top 6 in. of soil has not produced sufficient differences in plant growth to justify continuation of observations. Two heaps of lime of 100 tons each have been checked regularly for moisture at various depths to decide their suitability for open-air stock-piling. At a later date these heaps will be used to make a comparison of various spreading equipment.

CANTERBURY COLLEGE INDUSTRIAL DEVELOPMENT DEPARTMENT

Director: Mr. T. R. Pollard

This department of Canterbury University College has now completed two and a half years of successful operation, and assistance to industry during the year has been on an increasing scale, activities having extended to many parts of the South Island. The number of projects handled for industry was 254 and for Government Departments 45, covering a wide variety of work.

The Engineering Section has handled the design and construction of experimental or specialized equipment, including a counting-plate for wheat samples for the Crop Research Division. This plate is an adjunct to the vacuum wheat-counter previously developed by this Section and will provide a ready means of grouping one hundred grains in the sample. The design of a factory test panel for adjusting the operating temperatures of thermostatically controlled electric irons has enabled a manufacturer to speed up production. Advice has been given on the layout of drying-ovens and the measurement of temperatures therein.

The construction of an artificial ear by the Electrical and Electronics Section has enabled the department to assist in the standardization of test apparatus used in schools for the deaf. Experience in the techniques of measuring strain with electrical-resistance strain-gauges has enabled important measurements to be carried out at Roxburgh hydro-electric project. These measurements are associated with recording the pull required to draw steel anchor rods out of the schist rock which will form the foundation of the main spillway and dam.

The repair and calibration of industrial measuring equipment has enabled the recommissioning of much unserviceable equipment. College departments have made regular demands on the workshop facilities and some 228 jobs have been carried out, covering construction of apparatus, machining of test specimens, and general repairs to plant and services. A number of chemical problems have been handled in co-operation with the Dominion Laboratory.

During the course of the year the department has been granted a charter to issue test certificates for a limited number of different tests appertaining to aircraft equipment.

A Gisholt dynetric dynamic balancing-machine, loaned through the Ministry of Works, has been put in good working-order and is operating satisfactorily.

Reports have been issued on the following subjects: fire and explosion hazards due to electrical ignition of anæsthetic gases, a pure-tone audiometer, wheat-counter, investigation on the use of resistance strain gauges, and dental spot-welding unit.

MASSEY AGRICULTURAL COLLEGE

ANIMAL NUTRITION PROJECTS

Dr. C. R. Barnicoat

Milk Yield of Romney Ewes.—A four-year project was completed in which about 30 ewes were milked each season and their milk yield and compositions recorded. Full lambing records and growth data of about 80 other ewes were also recorded: these will relate information on the effect of twinnings, abnormal season, stage of lactation, condition of ewe, &c., on lamb growth rates.

Wear in Sheep's Teeth.—Visits were paid to farms and to ewe fairs at Apiti, Martinborough, and Blenheim. Several major projects have been completed during the year, and interesting relationships between form of jaw teeth and durability of teeth are apparent from the data obtained. Much practical information bearing upon wear of sheep's teeth as affected by the type of country, climate, rate of stocking, type of pasture, type of jaw, and type of teeth, has been collected. In addition to these, thousands of mouthing records of hundreds of individually tagged sheep and hundreds of photographs have been taken, and numerous jaws specially collected for chemical analyses.

ROMNEY X CHEVIOT CROSSBRED SHEEP EXPERIMENT

Professor G. S. Peren, Mr. W. R. R. Hewitt, and Mr. T. O. Phillips

Old contacts have been maintained and a number of new contacts made with farmers on marginal country and breeders of Cheviot rams. These contacts have yielded useful information of a general type which has considerably broadened the appreciation of the situation.

The results of the Cheviot Half-bred *v.* Romney trial, which has been carried out on the College's hill-country property near Aokautere since 1944, will be published shortly, and will include the results of the four-year trial of Cheviot half-bred cast-for-age ewes as producers of fat lambs when sired by Southdown rams.

PROGENY-TESTING INVESTIGATIONS

Dr. A. L. Rae

Data collected during the 1950–51 year on the problem of specific combining ability in sheep is to be analysed statistically. The range of data recorded from the 420 ewes and their progeny in this experiment includes fleece weight, count, handle, lustre, colour, staple length, hairiness, fleece quality, body conformation, birth weights, body weights, carcass measurements, block test, and export grade on the slaughtered wether lambs. From the design of the experiment these data will enable an appraisal to be made of the effects, if any, of specific combining ability, and are also suitable for analyses of such factors and effects as type of birth and rearing, age of dam, season and age at shearing, hereditability estimates, genetic and phenotypic correlations, genetic environment interactions, genetic interactions, and repeatabilities. Such analyses when added to those already made will make available much new and valuable information concerning sheep-breeding procedures and useful selection indices will be constructed, enabling more satisfactory progress in breed improvement.

INFLUENCE OF SIRE IN FAT LAMB PRODUCTION

Mr. R. A. Barton and Mr. T. O. Phillips

Carcass dissection of a sample of 18 lambs was carried out. Bone, muscle, and fat rates were determined, and, in co-operation with the Biochemistry Department, moisture, protein, and fat values were obtained. Three papers have been published on data obtained from the earlier phases of the investigation.

STUDIES OF SOME NEW ZEALAND ROMNEY MARSH STUD FLOCKS

Mr. H. Goot

Growth of Lambs and Hoggets.—This work, commenced in 1947, has been continued. Lambs born in 1949 have been weighed at regular intervals and their weights recorded. They have also been graded for "fleshing." The data collected over the last four years will be analysed to ascertain the effect of various factors on the variation in the growth of Romneys.

PLANT PROPAGATION

Dr. J. S. Yeates

Tip Grafting.—A further season's work has been done with this method in order to test it thoroughly and to gain further experience. The tests have been carried out with rhododendron species and hybrids, with deciduous azaleas, and with *Camellia reticulata.* The method has proved particularly successful with scions imported from Europe by air.

Rooting Experiments with Daphne odora.—Intensive trials have been repeated and extended. The trials have shown that, in general, best results appear to be obtained by a fifteen - seventeen-hour soak in a solution containing 1 part of alpha-naphthalene acetic acid in 30,000 of water with the addition of 2 per cent. of cane sugar and 0·2 per cent. of ammonium sulphate.

Other Rooting Experiments.—Intensive trials on Azalea (Ghent hybrids) this season again gave unsatisfactory results.

The following were treated in an exploratory manner as a preliminary to more extensive work: *Camellia japonica* var. *magnilæflora, Camellia japonica* "Emperor," *Forsythia intermedia spectabilis, Boronia heterophylla, Photinia glabra rubens, Feijoa sellowiana* var. *Coolidgei,* and *Taxus baccata* var. *fastigata.*

NEMATODE PARASITISM IN SHEEP

Dr. J. H. Tetley

The studies on the estimation of the date on which parasites are acquired by sheep were continued during the year. The investigation on the growth of the species *Cooperia curticei* has been completed and presented as a thesis.

The seasonal nature of roundworm parasitism in sheep has been investigated at the College for several years. During the past spring, roundworm parasitism departed from what has been experienced in the Manawatu district, to the extent that mature sheep were heavily infested; in order to follow up this peculiar occurrence, lambs which had been intended for other investigations were diverted to an epidemiological experiment in the field.

Anthelmintics.—A field investigation on a phenothiazine control programme begun the previous year was concluded last autumn, and a preliminary report has been presented.

MANURIAL TRIAL UNDER ROTATIONAL GRAZING

Professor A. W. Hudson and Mr. C. V. Fife

This experiment has now comprised twelve years' comparative effect of superphosphate, with and without heavy liming, and basic slag. Potash as an addition to super and lime is also under trial. The stock-carrying continues high, with lime causing an increase of about one ewe per acre winter carrying and potash having no effect on this soil type.

PAMPAS RESEARCH

Mr W. A. Jacques

An area established to study the effects of various fertilizer treatments on pampas has had gaps replanted following a bad take in the previous year. A hill-country stand planted in 1948 shows a definite superiority through planting on cultivated ground, compared with spot cultivation of plantings made in a pasture and no cultivation. Plants in cultivated ground averaged twenty-four tillers per plant, against eleven for plants in grass.

Plants showing variable growth characteristics have been selected for further study.

FARM DRAINAGE

Professor A. W. Hudson and Mr. H. G. Hopewell

Publications.—A comprehensive bulletin, " The Draining of Farm Lands," was published during the year. Several trials concerning thickness of mole-plough blade, speed and direction of pulling mole drains, depth of mole drains, and types of junctions of major and minor moles have reached the stage where results may be published.

Routine Measurements.—Outflow measurements have been continued, and can now be extended, since clocks for recording mechanism have now been received. Some tile experiments designed to be observed for silting effects have also been examined.

Trial to Measure the Effect of Drainage on Stock-carrying Capacity.—This has been taken a stage further and will be sown to permanent pasture this autumn.

Concrete Tiles.—Considerable evidence has been collected that most concrete tiles are of very poor quality. Arrangements are being made to investigate the factors associated with poor quality and to lay down long-term experiments to test the lasting qualities of concrete tiles made to specifications of the New Zealand Standards Institute.

SCIENTIFIC LIAISON SERVICE

Scientific liaison activities overseas have continued normally during the year. This essential service ensures, as far as practicable, that New Zealand is kept advised of the most recent scientific and technical developments in the United Kingdom, North America, and Australia. By direct contact with overseas research organizations, to which the Department is greatly indebted, liaison officers obtain a great deal of valuable information that would not normally reach research workers and industry in the Dominion.

London.—Dr. E. Marsden, Scientific Adviser, London, returned to New Zealand for several months for a refresher visit. Apart from normal duties, liaison staff represented New Zealand at scientific conferences and on committees, assisted in the appointment of scientists to fill vacancies in New Zealand, and advised and forwarded progress reports on New Zealand national research and other scholars in the United Kingdom.

Washington.—The appointment of an Assistant Scientific Liaison Officer is required to bring the staff to establishment strength. As far as possible, the Liaison Officer has maintained contact with the more important research establishments, and a great deal of most valuable information has been sent to New Zealand.

Melbourne.—Apart from regular work, the Liaison Officer has prepared a number of special technical reports on research work in Australia of particular interest to New Zealand.

COMMONWEALTH AGRICULTURAL BUREAUX

One of the largest and most successful activities being conducted in the field of science on a Commonwealth-wide basis is that of the Commonwealth Agricultural Bureaux (C.A.B.). The organization consists of ten Bureaux, three Institutes, and a Headquarters, all located in the United Kingdom, which prepare and publish abstracts of and reports on the scientific and technical literature of the world in the very important fields of agriculture and forestry. Without this valuable service, research workers and others would not be able to keep in touch adequately with the world's literature in these subjects.

The Governments of the Commonwealth contribute to the support of the Bureaux and the funds are augmented by the world-wide sale of their publications. The C.A.B. is represented in New Zealand by a Liaison Officer, who is a member of the Department, and by thirteen specialist Official Correspondents each representing a Bureau or Institute.

The five-yearly Review Conference of the C.A.B. was held in London in 1950, the New Zealand delegates being Mr. F. R. Callaghan, Secretary of the Department, Dr. J. F. Filmer, Director of the Animal Research Division of the Department of Agriculture, and Dr. E. Marsden, Scientific Adviser, London. At the Conference the vital importance of the work was stressed and developments considered essential were proposed.

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